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The Effect of Short and Long Fiber on Impact Strength in High Density Polyethylene-Fiberglass Composite

Elgi Oki Andeska [a], M. Dalil,[a,*] and Dodi Sofyan Arief,[a]

[a)] *Mechanical Engineering Department, Faculty of Engineering, Universitas Riau, Indonesia*

*Corresponding author: dhalilm@yahoo.com

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ABSTRACT

This study aims to investigate the HDPE (High Density Polyethylene) reinforced with fiberglass to increase strength and toughness into a composite that has the potential to replace ABS (Acronitrile Butadiene Styrene). The composites were made with variations in composition based on volume fraction. The HDPE as matrix and fiberglass as reinforcement through the mixing method, molded in a heating machine (T=140°C), pressed with a pressing time of ±45 minutes. Then, the specimens were cut according to ASTM D6110 standard, and the Charpy impact test was performed. The impact of long fiber for the HDPE composition of 70%vol and fiberglass 30%vol, the average impact strength was 176.838 Joule/mm². The long fiber for the HDPE composition of 80%vol and fiberglass of 20%vol, the average impact strength was 208.08 Joule/mm². The impact of short fiber for HDPE composition of 70%vol and fiberglass of 30%vol, the average impact strength was 72.858 Joule/mm². The short fiber for HDPE composition 80%vol and fiberglass of 20%vol, the average impact strength was 33.394 Joule/mm². Based on research of ABS mixture at 40%/60%vol mixture variation, the average impact strength was 24.8 Joule/mm2 and the 20%/80%vol mixture variation, the impact strength was 18 Joule/mm². In conclusion, the impact strength of the ABS was lower than the HDPE-Fiberglass composite. Therefore, the HDPE-Fiberglass composite can be used as a substitute for ABS for car bumpers.

KEYWORDS: *HDPE, Short and Long Fiberglass, Impact Strength, Charpy Method.*

1.0 INTRODUCTION

The composite is materials formed from two or more components (reinforcing materials and matrix), which have different characteristics from the constituent materials and are mixed macroscopically while still having clear and identified phase boundaries [1-2]. The composite materials generally consist of two elements, namely fiber as a filler and a matrix as a fiber binding material. As a filler material, the fiber is used to resist the forces acting on the composite material, and the matrix serves to protect and bind the fiber so that it can work well against the forces that occur. Therefore, for the fiber material, a strong, rigid and brittle material is used, while the matrix material is selected from materials that are tough, soft and resistant to chemical treatment.

The composite is a combination of two or more materials that have different phases into a new material that has better physical or mechanical properties than both [3-4]. (Callister & Rethwisch, 1993). If this combination occurs on a macroscopic scale, it is referred to as a composite, the composite consists of a matrix. The matrix is the material that keeps the reinforcement in place, controlling the electrical and chemical properties of the composite. Another function is to protect the fiber from environmental effects and damage and affect the appearance of a composite material. Usually, the materials used as the matrix are metals, ceramics, and polymers. If resin is used, the rigid strength will be lower but more ductile. The type of filler used is a polymer in the form of HDPE resin.

The HDPE stands for High Density Polyethylene is a development of PE (Polyethylene). The HDPE resins are resistant to chemical reactions because their intermolecular forces are very strong, this makes them insensitive to various acids and bases. The HDPE resin's ability to with stand the effects of contact with chemicals makes it popular as a container for various compounds, this material is able to with stand the effects of acids, bases, alcohols, vegetable oils and ketones. Resin is often called a thermoset.

Thermoset is one type of plastic, that is widely used for composite materials with fiber reinforcement. The use of thermoset as a matrix has several advantages such as being able to bind fibers easily and well, having low viscosity, having good adhesiveness with reinforcing materials, good rigidity, good dimensional stability, light weight and corrosion resistance.

Reinforcement is one of the main parts of the composite whose role is to with stand the load received by the composite material so that the high and low strength of the composite depends on the reinforcement used. Reinforcing materials are

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usually rigid and tough, commonly used reinforcing materials are particle types, natural fiber fibers, carbon fibers, glass and ceramic fibers, generally reinforcement in the form of fiber, metal, or fiber [6-8]. The type of reinforcement used is fiber reinforcement.

Fiberglass is a form of glass fiber from molten glass that is deliberately pulled to become a strong thin fiber. The nature of fiberglass is strong, light weight, and not easily brittle enough to explain why fiberglass is widely used for bathtubs, roofs, to ships and airplanes. The type of fiber used in this research is to use short glass fibers and long glass fibers where these fibers are known to be corrosion resistant, extrude resistant, hydrolysis resistant, and have high mechanical properties [7-9].

This composite may use to impact testing, according to Dieter [10], the impact tests are used to determine the tendency of a material to become brittle or ductile based on its toughness properties. Impact test results also cannot read directly the fracture conditions of the test rods, using the Charpy method. The purpose of the Charpy Impact test is to determine the brittleness or ductility of a material (the specimen) to be tested by loading suddenly against the object to be tested statically, referring to the ASTM D6110 standard. The test object is placed in a horizontal position and the loading direction comes from the back of the notch, the size of the notch is 45^{O}, the depth of the notch is 2.5 mm in the middle.

In general, as with fracture analysis on test objects, impact fractures of plastic materials (polymers) are classified into 3 types, namely:

1. Ductile fracture is a fracture caused by a static load applied to the material, starting with plastic deformation first and then breaking and if the load is removed, the crack propagation stops, marked by a fibrous fracture surface.
2. Brittle fracture is a fracture phenomenon in materials that begins with cracks occurring rapidly compared to ductile fracture without prior plastic deformation and in a short time, characterized by a flat fracture surface.
3. Mixed fracture is a combination of two types of fracture: ductile and brittle fracture.

To determine the potential energy absorbed by the specimen in the impact test, use the equation:

$$\begin{aligned} Es &= Initial\ energy - Remaining\ energy \\ &= m.g.h - m.g.h \\ &= m.g\,(R - Rcos\ \alpha) - m.g\,(R - Rcos\ \beta) \\ &= m.g.R\,(cos\ \beta - cos\ \alpha) \end{aligned} \tag{1}$$

Where:

Es = Absorption energy (J)
m = Weight of the pendulum (kg)
g = Acceleration due to gravity (m/s^2)
R = Length of pendulum arm (m)
A = Pendulum angle before swinging (°)
B = Pendulum swing angle after breaking the specimen (°)

Impact value can be calculated by the equation:

$$HI = Es : A \tag{2}$$

Where:

HI = Impact Price (J/mm²)
Es = Absorbed Energy (J)
A = Cross-sectional area under the notch (mm²)

Impact testing aims to determine how much a material is able to with stand a sudden load. The test results data were obtained from composite testing using the Charpy impact test tool. The objectives of this research: (a) knowing the impact strength of High-Density Polyethylene composites with short fibers (short fiberglass) and long fibers (long fiberglass), (b) conduct an analysis of the impact strength, and its relationship to the effect of short fibers and long fibers on the HDPE composite structure. So, it can be used for car bumpers to replace ABS, which is commonly used by the public. The benefits obtained in research such as knowing the best impact resistance between the HDPE reinforced with short fibers and long fibers and provide recommendations for potential materials for car bumpers at a much lower price.

2.0 METHODOLOGY

The research was employed the experimental method to analyze the effect of short and long fiber HDPE-Fiberglass on impact testing. The impact tests were conducted in Polytechnic Laboratory of ATMI Surakarta. The research flow can be seen in Figure 1.

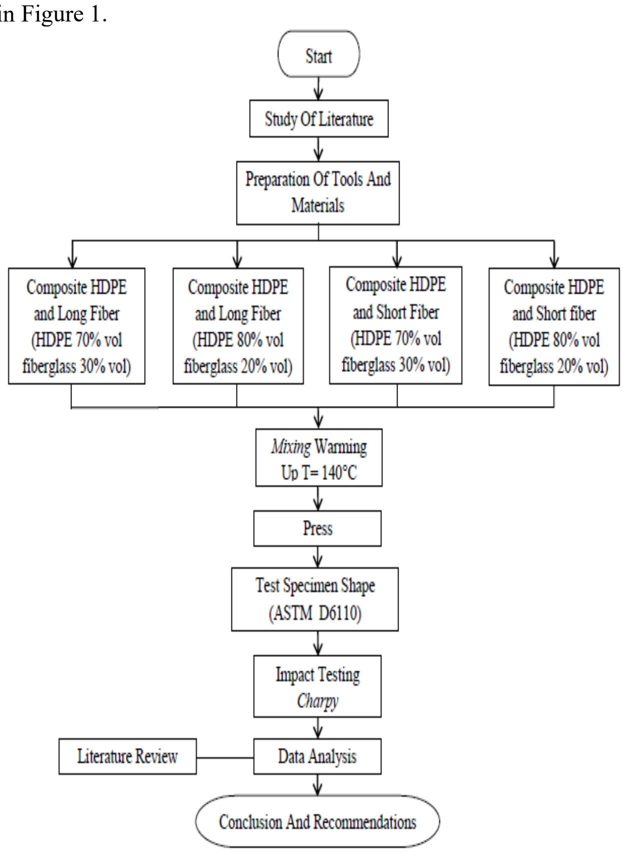

Figure 1: Schematic of the research

2.1 Tools and Materials

The preparation of tools and materials used in the research, starting from the process of making specimens to the process of testing composites was carried out.

1. Tools
   The equipment used in this study is as follows:
   a. Heating and pressing devices, namely heating, work when the HDPE (Resin) material is heated so that it melts properly. Pressing serves to make the material

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more evenly distributed and dense so that by pressing the material there is no air cavity or bubbles formed in the specimen to be tested, the press machine with heating (Figure 2).

Figure 2: Machine press with heater

Figure 3: Impact testing machine HIT 5.5P Zwick Roell

b. The shape of the specimen refers to the ASTM D6110 standard.
c. Use sand paper to smooth the surface of the test object and smooth the rough sides of the test object to minimal the risk of failure.
d. Impact test equipment used the Charpy engine test equipment using the HIT 5.5P impact engine with the Zwick Roell brand (Figure 3).
e. Testing (Collection) was carried out at the Plastic Materials Laboratory of the Polytechnic ATMI Surakarta.

2. Materials
The materials used in this study are as follows:
a. Resin HDPE in the form of granules (Figure 4).

Figure 4: The Resin of HDPE

b. Long fiber type Aqua proof sheet form (Figure 5).

Figure 5: Long fiber (Aqua proof)

c. Short fiber type of short fiber used; fiberglass Chopped Strand 101C with a length of 3.2 mm (Figure 6).

Figure 6: Short fibers chopped strand 101C

d. The materials are arranged in a matrix and fiber ratio, namely the percentage of HDPE 70% vol, fiber 30% vol and HDPE 80% vol, fiber20% vol, based on the mold:
Long : 23 cm
Wide : 9,5 cm
Tall : 1,2 cm

- With HDPE fraction 70% vol (0.7 g/cm³) fiber 30% vol (0.3 g/cm³)
  Fiber Density 2,4 g/cm³
  Matrix Density 0,9 g/cm³
  = LxWxH = 262 cm³
  Fiber Volume = 262 cm³ x 0,3 cm³
  = 78,6 cm³
  Matrix Volume = 262 cm³ x 0,7 cm³
  = 183,4 cm³
  Fiber Mass = 78,6 cm³ x 2,4 g/cm³
  =188,64 g
  Matrix Mass = 183,4 cm³ x 0,9 g/cm³
  = 165,06 g
- With HDPE fraction 80% vol (0.8 g/cm³) fiber 20% vol (0.2 g/cm³)
  Fiber Density 2,4 g/cm³
  Matrix Density 0,9 g/cm³
  = LxWxH = 262 cm³
  Fiber Volume = 262 cm³ x 0,2 cm³
  = 52,4 cm³
  Matrix Volume =262 cm³ x 0,8 cm³
  = 209,6 cm³
  Fiber Mass = 52,4 cm³ x 2,4 g/cm³
  = 125 g
  Matrix Mass = 209,6 cm³ x 0,9 g/cm³
  = 188 g

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2.2 Composite Manufacturing

The preparation to manufacture of the composite is as follows:

1. The HDPE granules were weighed according to the percentage used, which was between the percentage of HDPE 70% vol and 80% vol (Figure 7).
2. The fiber to be used in the study was weighed according to the percentage used in the study, namely with a fiber percentage of 30% and 20% vol (Figure 8). The base and cover of the mold were given a layer aluminum foil (Figure 9) to prevent the melting resin did not stick to the top or base heater equipment. The mold size was 23 cm long, 9.5 cm wide and 1.2 cm high (Figure 10).
3. Then, in heating machine, the melting temperature of resin HDPE (T=140°C) then the mold is placed on a heater then the two materials are slowly inserted one by one starting with melting resin then fiber and so on until the maximum number of prints (Figure 11).
4. After resin heat then the two ingredients that have been mixed evenly pressed with machine press with a long pressing of ± 45 minutes, after that the test specimen is waited for it to cool and dry then it is removed from the machine press and mold (Figure 12).
5. The specimen is lifted from the heating machine and press then the specimen is removed from the mold and then cleaned (Figure 13).

Figure 7: Weighing of HDPE granules using digital scales

Figure 8: Weighing of long and short fibers using a digital scale

Figure 9: Coated mold cover aluminum foil

Figure 10: Test specimen mold

Figure 11: Resin heating in a heating machine with hot temperature (140°C)

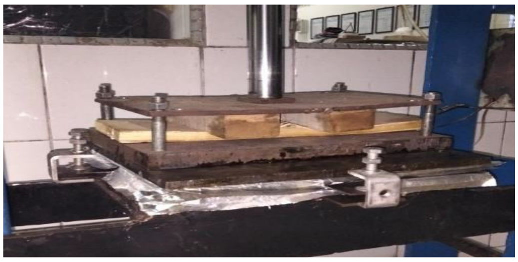

Figure 12: Pressing the test specimen on the machine press with a long pressing ± 45 minutes

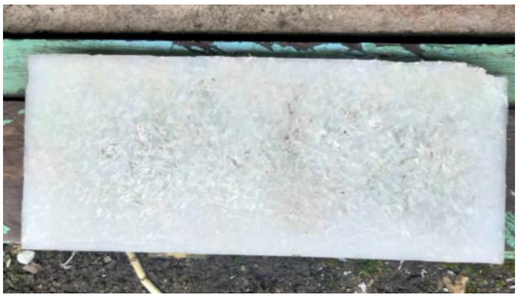

Figure 13: Test specimen after lifting from machine press and mold

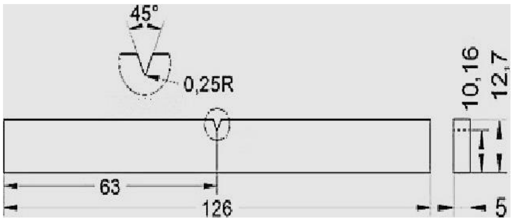

Figure 14: The ASTM D6110 testing standard

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6. Then, the specimen is measured with the ASTM D6110 standard. The specimen length of 126 mm, a width of 12.7 mm and for a minimum thickness of 3 mm a maximum thickness of 12.7 mm, the notch was at a distance of 63 mm from one end of the overall measurement length, the notch depth of 2.5 mm with a "V" angle 45° (Figure 14). Measuring test specimens using a ruler, and shaped according to ASTM D6110 standard of the impact testing machine. Then, the specimen was cut using a saw and cleaned with sand paper until the surface of the specimen more even. After all the specimens were cleaned, the specimens were ready for testing (Figure 15).

Figure 15: Sample test specimen with ASTM standard D6110

2.3 Specimen Test

The testing procedures to be carried out are as follows:

1. Before carrying out impact testing, check whether the test machine was functioning properly. Measurement of the test specimen was it in according with the standard of the test to be carried out then give a notche on the test of specimen (Figure 16).

Figure 16: Notch creation on specimen test

2. Before testing the test specimen, determine the Impact test to be carried out with the method of Charpy (Figure 17).

Figure 17: Testing with the method of Charpy

3. After the machine and the test specimen were ready, then carry out the impact test method of Charpy. The test used the Zwick HIT 5.5P type impact engine (Figure 18), with a capacity of 2 Joules and 4 Joules, the standard impact testing used the ASTM D6110, the pendulum length of 330 mm, the swing speed was 2,901 m/s and it was carried out at the test temperature of 25°C.
4. After the test had been carried out, then the data was obtained through the impact resistance table on each specimen based on the volume fraction.

Figure 18: Testing of test specimens with standard ASTM D6110

3.0 RESULT AND DISCUSSION

Impact testing was carried out using the method Charpy using the Zwick HIT 5.5P Impact testing machine with a capacity of 4 Joules. Impact testing standard refers to ASTM D6110 standard. The test was carried out at the Plastic Materials Laboratory of the Polytechnic ATMI Surakarta, with the results of the impact test data through the impact strength table of each HDPE composite fraction fiberglass is as follows:

3.1 Impact Test Results

The following are the results of the Impact testing that has been carried out in the study:

a. Impact test results for 5 specimens with a composition of 30% fiberglass length and 70% HDPE in volume fraction, and fracture shape after being given Impact load. It can be seen in Table 1 and Figure 19.

Table 1: Impact strength of long composites fiberglass-HDPE with 30% fiberglass and 70% HDPE in volume fraction.

No. of Specimen	Height (mm)	Width (mm)	bN (mm)	Angle of rise (°)	Angle of release (°)	Total mass kg	W (Joule)	Impact Strength J/mm²	Type of failure
1	13,66	9,85	10,37	29,34	107,5	0,4754	1,79939	182,68	H
2	13,22	10,12	10,26	62,73	107,5	0,9508	2,32647	**229,89**	H
3	13,67	9,72	10,32	75,69	107,5	0,9508	1,67672	172,5	C
4	13,22	9,94	10,36	70,47	107,5	0,9508	1,945	195,67	H
5	13,74	10,16	10,35	87,48	107,5	0,9508	1,05106	103,45	C
						Mean	**1,759728**	**176,838**	

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Figure 19: Composite specimen fracture shape for long of fiberglass- HDPE with 30% fiberglass and 70% HDPE in volume fraction

Impact test results for 5 specimens with 20% fiber composition glass length and 80% HDPE in volume fraction (Table 2) and fracture shape after being given impact load (Figure 20).

Table 2: Impact strength of composites fiberglass-HDPE with 20% composition long fiberglass and 80% HDPE in volume fraction

No. of Specimen	Height (mm)	Width (mm)	bN (mm)	Angle of rise (°)	Angle of release (°)	Total mass kg	W (Joule)	Impact Strength J/mm²	Type of failure
1	12,54	10,81	10,32	54,94	107,5	0,9508	2,45802	227,38	C
2	13,48	10,23	10,35	62,37	107,5	0,9508	2,34364	**229,09**	H
3	13,53	11,1	10,35	64,71	107,5	0,9508	2,23106	201	C
4	12,24	11,46	10,35	66,96	107,5	0,9508	2,12074	185,06	C
5	12,95	10,83	10,37	66,51	107,5	0,9508	2,14296	197,87	C
						Mean	**2,259284**	**208,08**	

Figure 20: Composite specimen fracture shape for long of fiberglass- HDPE with 20% fiberglass and 80% HDPE in volume fraction

Impact test results for 5 specimens with a composition of 30% fiberglass short and 70% HDPE in volume fraction is shown in Table 3 and the fracture shape after being given Impact load in Figure 21.

Table 3: Impact strength of composite for short fiberglass-HDPE (30%: 70%) in volume fraction

No. of Specimen	Height (mm)	Width (mm)	bN (mm)	Angle of rise (°)	Angle of release (°)	Total mass kg	W (Joule)	Impact Strength J/mm²	Type of failure
1	13,62	10,62	10,3	85,05	107,5	0,4754	0,58973	55,53	C
2	13,3	9,98	10,25	76,32	107,5	0,4754	0,82103	82,27	C
3	13,04	10,03	10,29	74,61	107,5	0,4754	0,86551	**86,29**	C
4	13,02	9,58	10,37	79,92	107,5	0,4754	0,72637	75,82	H
5	13,36	10,02	10,31	82,98	107,5	0,4754	0,64505	64,38	C
						Mean	**0,729538**	**72,858**	

Figure 21: Composite specimen fracture shape for short of fiberglass- HDPE with 30% fiberglass and 70% HDPE in volume fraction

Impact test results for 5 specimens with 20% fiber composition glass short lengths and 80% HDPE in volume fraction are shown in Table 4 and fracture shape after being subjected to impact loads in Figure 22.

Table 4: Impact strength of composites fiberglass-HDPE with 20% composition short fiberglass and 80% HDPE in fraction volume.

No. of Specimen	Height (mm)	Width (mm)	bN (mm)	Angle of rise (°)	Angle of release (°)	Total mass kg	W (Joule)	Impact Strength J/mm²	Type of failure
1	13,62	11,63	10,2	99,09	107,5	0,9508	0,42924	36,91	C
2	12,03	11,32	10,36	92,7	107,5	0,4754	0,38411	33,93	C
3	12,91	12,46	10,37	94,32	107,5	0,4754	0,34066	27,34	C
4	12,29	11,24	10,3	90,45	107,5	0,4754	0,44456	**39,55**	C
5	12,46	11,98	10,32	93,96	107,5	0,4754	0,35031	29,24	C
						Mean	**0,389776**	**33,394**	

Figure 22: Composite specimen fracture shape for short of fiberglass-HDPE with 20% fiberglass short and 80% HDPE in volume fraction

3.2 Discussion

From the test results, the impact strength for the long fiber of composite is higher than the short fiber as this is shown in tables (1-4) and figures (19-22). The impact strength comparison of composites for the long and short fiberglass with matrix HDPE is depicted in Table 5.

Table 5: Comparison of the Impact strength of composites long fiberglass and short fiberglass with matrix HDPE

Composite	% Volume	Average Impact Strength	Average Solid Shape
Long Fiberglass-HDPE	30-70	176,838 J/mm²	H
	20-80	208,08 J/mm²	C
Short Fiberglass-HDPE	30-70	72,858 J/mm²	C
	20-80	33,394 J/mm²	C

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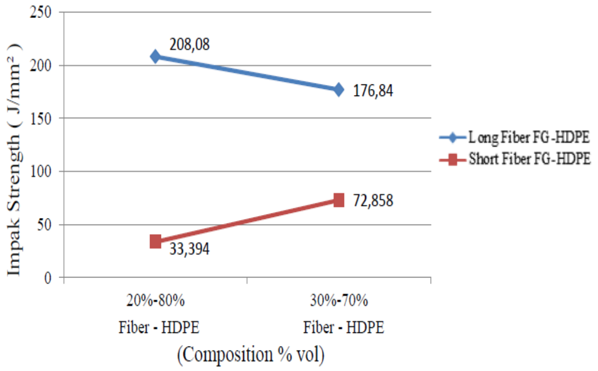

Figure 26: Comparison of impact strength of composites long and short fiberglass with HDPE matrix for the composition of 20%-80% and 30%-70% in volume fractions

The form of the fault was categorized as C (Complete break) that meaning the pendulum was very strong in impact the specimen. The specimen experienced a complete break, which was fractured complete break have brittle properties. The form of the fault was categorized as H (Hinge), which the pendulum was strong enough to injure the specimen, but not to the point. It was broken in the shape of a hinge, which was fractured hinge has a tenacious nature.

Impact strength of long fiberglass-HDPE was known that the higher the fiber count, the lower the impact strength. While on fiberglass short with the higher the number of fibers, the impact strength increases (Figure 21). The impact strength decreased with increasing number of fibers in the composite long fiberglass-HDPE was due to its high fiber count resin HDPE with a fairly high viscosity at liquid temperature, resin HDPE did not fill the gaps between the fibers well in the center of the specimen, while at the hot press location, resin liquids well and able to fill the gaps between the fibers. The inability to fill the gap properly can be caused by the insulating nature of HDPE. So, the temperature in the center of the specimen did not reach the liquid temperature. If the temperature was increased on the outside, the HDPE would turn brown because it passed through its melting point. So, the process curing with a temperature can be endured (holds).

It was not possible to mix the long fibers and resin, because it can cause the fiber to break. The process can be done by pouring resin on each layer of fiber. The resin unable to coat the fiber because the viscosity increases every second there was decreased temperature. In thin specimens, hot molds can help, while in thick specimens, hot molds cannot melt the inside of the specimen because of the insulating nature of HDPE. According [11] stated that processing can slightly change the strength statistics. The low impact strength of the composite with the higher percentage of long fibers can be seen in the microstructure of the composite fiberglass-HDPE.

From Figure 27, the gap or void in the specimen with a percentage of 30%-70% vol was larger and longer than the percentage of 20%-80% vol. So that a large gap causes the specimen to break easily due to load compared to specimens with smaller gaps. In Figure 27(a), the form of the fault was a mixed fault between faults fibrous and fracture granular between ductile fractures and brittle fracture. In Figure27 (b), it was more inclined to the type of fault fibrous ductile fracture, characterized by a fibrous surface that absorbs light [12].

In specimens with a percentage of 30%-70% vol, the specimens did not break completely after being given an impact load. This shown a high impact strength because at a higher percentage of fiber, and this high strength only occurred in denser and denser fibers. According to [13] stated that the impact energy increased with an increasing in the volume fraction, above 30% of the fiber volume, while in the deeper part there was a gap that greatly affects the impact strength and decreases. In specimens with a percentage of 20%-80% vol the Impact strength was higher because the gap of smaller and short so load transfer still occurred and caused the higher impact strength than specimens with long gaps.

From Figure 28, the gap or void in the specimen with a percentage of 30%-70% vol was less compared to the percentage of 20%-80% vol and the fibers that were more tightly arranged. The percentage of 20%-80% vol was less the number of fibers, so that the impact strength was higher than the percentage of fiber of 30%-70% vol. In Figure 28(a) Where the shape of the fibrous fracture (fibrous fractures) more tenacious (ductile) the fracture surface that absorbs light.

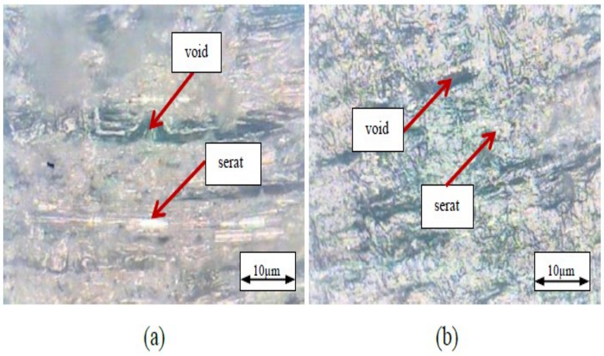

Figure 27: Composite specimen surface for long fiberglass-HDPE viewed with an optical microscope at 10x magnification, (a) 30%-70% vol fiberglass-HDPE and (b) 20%-80% vol fiberglass-HDPE

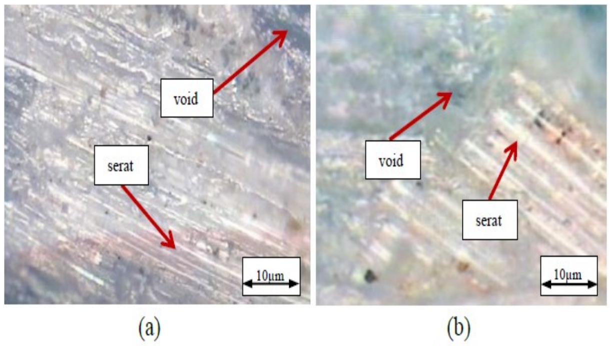

Figure 28: Composite specimen surface for short fiberglass-HDPE viewed with an optical microscope at 10x magnification, (a) 30%-70% vol fiberglass-HDPE and (b) 20%-80% vol fiberglass-HDPE

Furthermore, the cause of the unevenness of the fiber was coated by resin because in the process of making composites.

In Figure 28(b), it was more inclined to fracture granular or crystalline where the cleavage of the grains of brittle

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material characterized by a flat fracture surface capable of providing a high or shiny light reflection [10].

In short fiber composites, all specimens break completely, because the short fibers did not transfer the load to each fiber. The crack propagation can occur between the fiber pile boundaries because too short fibers make the composite more brittle. According to Pakningi et al. [14] with a fiber length of 3 cm will get a high impact resistance value, the effect of fiber length can increase or decrease the mechanical properties of the composite. The longer the fiber used, the higher the mechanical properties obtained and vice versa. The statistical nature of brittle fiber failure that the primary fracture surface leaves the connecting segments of the fiber available to bridge stresses, can change the strength statistics [11]. The impact strength of long fiber composites is higher than that of short fiber composites [15]. According to Rajeshkumar et al. [16], the composites loaded with particles and fibers with a length of 30 mm had a higher impact strength. This was supported by [17-19], which stated that the impact strength increasing in the volume fraction and fiber length. The longer the fiber used, the less crack deflection, so the impact strength was getting better.

The majority of fractures in long fibers and short fibers in the 70%-30% vol fraction and in the 80%-20% vol fraction were brittle fractures. Subsequence, the specimen was split into two parts, this was becaused the load from the pendulum had been distributed throughout fiberglass. So, there was a collision with the pendulum, resin, which received the load first would be broken first, then followed by fiberglass bound by it, the incident occurred at all layer's fiberglass.

The impact strength for composite fiberglass-HDPE (High Density Polyethylene) better than ABS (Acronitrile Butadiene Styrene) [20]. In this research, the composites fiberglass-HDPE found variation of 40%/60% vol the impact strength value of 24.8 Joule/mm² and at a mixed variation of 20%/80% vol the impact strength value of 18 Joules/mm². It was lower than the composites fiberglass-HDPE in the mixing variation of 30%/70% vol, for long fiber, has an impact strength of 176.838 Joule/mm² and for short fiber of 72.858 Joule/mm². In the mixing variation of 20%/80% vol, fiberglass-HDPE for long fiber has an Impact strength of 208.08 Joule/mm² and for short fiber 33.394 Joule/mm². Therefore, the composite of fiberglass-HDPE may potential to be used as a substitute for ABS (Acronitrile Butadiene Styrene) for car bumpers.

4.0 CONCLUSION

The impact strength of the composite High-Density Polyethylene (HDPE) with the long fiberglass is higher than short fiberglass. In composites of long fiber with 70% vol of HDPE fraction and 30% vol of fiberglass, is found the average energy absorbed from the specimen of 1.759728 Joule and the average impact value of 176.838 Joule/mm². The HDPE fraction 80% vol, 20% vol long fiber is found the average absorption energy of the specimen of 2.259284 Joules and the average impact value of 208.08 Joule/mm². In short fiber composites with 70% vol of HDPE fraction and 30% vol of fiberglass is obtained the average absorption energy of the specimen of 0.729538 Joule and the average impact value of 2.858 Joule/mm². In the HDPE fraction 80% vol and short fiber 20% vol, it is found the average absorption energy of the specimen of 0.389776 Joule and the average impact value of 33.394 Joule/mm².

The high impact strength of long-fiber composites for High Density Polyethylene (HDPE) compared to composites with short fibers because in long fibers there is a transfer of load to each fiber while in short fibers. The load can cross the boundary or end of the fiber and the ability to with stand impact loads is lower. Meanwhile, the decrease in the impact strength of long fiber composites with the higher percentage of fiber is due to the incomplete mixing of the resin with the fiber in the center of the specimen, a larger gap and cause the impact strength to decrease. The composite fiberglass-HDPE may be used as a substitute for ABS (Acronitrile Butadiene Styrene), which the common material used among the public for car bumpers. It is because of the strength of the impact fiberglass-HDPE is higher than ABS at a mixed variation of 40%/60% vol. The average impact strength is 24.8 Joule/mm², and at a mixed variation of 20%/ 80% vol the impact strength is 18 Joule/mm².

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