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The effect of post-curing temperature on mechanical properties of coconut coir fiber reinforced polyester composite

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Abstract. This study used post-curing training as a method of strengthening. The smoking process was a process carried out in the form of heating the specimen at a certain temperature to improve the properties possessed by the composite. The purpose of this study was to study the effect of post-curing temperature on the impact strength of coconut coir fiber composites with temperature variations of 600ºC, 700ºC, 800ºC, 900ºC, 1000ºC. Specimens were prepared using a mixing method for mixing ingredients and a hand lay-up where in the composite volume fraction is prepared according to each specimen, which is 70% polyester and 30% coconut coir fiber. Each specimen is heated for 60 minutes in a conventional oven. Average impact strength and impact energy per unit area increases with the increase in post-curing temperature due to the fact that the movement of composites as well as the reduction of holes in the composites and adhesion to one another (suturing) can improve mechanical testing. The highest strength values obtained in the specimen with an increase in T = 100°C, ie 18,509 J for the average impact energy and 0,1434 J/mm^2 for impact energy per unit area average.

1. Introduction

With the development of the industrial world this day, material requirements for a product are increasing but the use of metal materials in various product components is decreasing. This is caused by the weight of components made of metal, the formation process is relatively difficult, can experience corrosion and expensive production costs. Therefore, many other materials have been developed that have characteristic properties that are suitable with the desired metal material characteristics. One material that has been developed today is composite. Composite is a material combination between two or more components or materials that have a number of properties that cannot be owned by each of these components [1].

Natural fiber reinforced composite material is one of the right choices. Coconut with the Latin name Cocos nucifera is one of plant type that produces natural fibers. During this time coconut fibers are only used as a base for making doormats, brushes, and others. Things into consideration the use of this fiber is the use of coconut fibers are still minimal [2].

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For this study, researchers used polyester resin as a matrix of composite materials. Polyester resins are the most widely used resin in a variety of applications that use thermoset resins, both separately and in the form of composite materials. Although mechanically, the mechanical properties possessed by polyester are not very good or just mediocre. This is because this resin is easy to obtain, the price is relatively affordable and most importantly it is easy in the fabrication process. The type of polyester resin used as a composite matrix is the unsaturated polyester type which is a thermoset that can undergo curing from the liquid phase to the solid phase when it gets the right treatment [3].

This study uses post-curing training as a method of strengthening. The smoking process is a process carried out in the form of heating the specimen at a certain temperature to improve the properties possessed by the composite. The smoking process is carried out by heating the specimen material at a certain temperature, but the temperature cannot exceed the glass transition temperature, because if it exceeds the temperature it will cause the material to soften and if the temperature of the material is increased, it will exceed the melting point of the material, and it will melt [1].

Several studies that have been conducted regarding the use of natural fibers by the method of post-curing reinforcement are investigating the effect of post-curing temperature on tensile testing of composite fibers reinforced epoxy resin woven banana fiber. The temperature variations used were 25ºC, 70ºC, 80ºC, 90ºC, and 100ºC, from this study the highest tensile strength was obtained at a curing temperature of 100ºC, with a value of 42.82 MPa. Increased tensile strength up to 40.26% of non-curing specimens [1].

Study on the effect of temperature in the mechanical properties of hybrid polyester fiber reinforced glass fiber and goal fiber composites. The temperature variations used are 100ºC, 150ºC, and 200ºC with each variation of time for 1 hour, 2 hours and 3 hours. From the research results obtained, specimens with variations in temperature of 100ºC with a test time of 1 hour have the highest tensile strength of 62.264 MPa [4].

The purpose of this research was to study the effect of post-curing temperature on mechanical properties of coconut coir fiber reinforced polyester composite.

2. Experimental

2.1. Materials

Polyester resins, Metyl Etyl Ketone Peroxide (MEKPO) catalysts, Sodium Hydroxide (NaOH) solutions obtained from Chemical Sources and coconut coir fibers obtained from coconut milk merchant waste at the Ogan Ilir Indralaya market, where existing coconut coir is usually disposed of it's useless The coconut husk is then separated from the coconut shell, then the fibers are washed thoroughly and dried in the sun. Then after drying, the coconut fiber is combed to separate the fiber from the coir meat using a wire comb. The fibers that have been combed are then cut to a size of ± 5 mm and soaked in an alkaline solution (NaOH) at 5% for 2 hours. The fiber which has been soaked for 2 hours is then dried.

2.2. Composite preparation and experimental method

In this study, dried coconut fibers were then mixed with polyester resin with a volume fraction of 30% coconut fiber and 70% polyester resin. Specimens that have been mixed are stirred manually until the mixture is solid. Then before going to the printing stage, we prepare a test mold that has been smeared with oil. Then the specimen is put into the mold to dry. The dried specimens were then removed from the mold and given heat treatment with temperature variations of 60ºC, 70ºC, 80ºC, 90ºC, and 100ºC in a conventional oven for 60 minutes. Heated specimens can then be tested.

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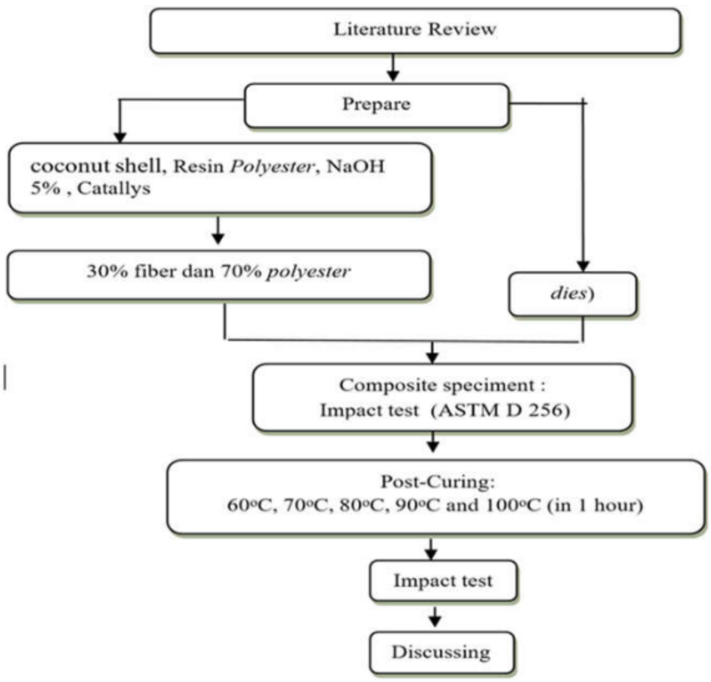

Figure 1. Experimental method

Figure 2. Composite specimen

2.3. Impact testing

The impact test is carried out by the Charpy impact test. The Charpy impact test measures the resistance of the material to the impact of the pendulum that vibrates. The impact strength is calculated from the impact energy divided by the cross-sectional area of the sample. In this study, tests using the standard Charpy and Charpy test methods for composites meet ASTM D 256 standart.

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Figure 3. Charpy impact machine

3. Results and Disccusions

Here are the results of impact testing has been done is in Table 3 below:

Table 1. Impact testing results

Kode Spesimen *(T=Temperatur)*	$\alpha(^0)$	θ $(^0)$
	90	85,9
Non post-curing	90	85,9
	90	85,7
	90	85,5
$T=60^0C$	90	85,7
	90	85,7
	90	85,1
$T=70^0C$	90	85,1
	90	85,2
	90	84,9
$T=80^0C$	90	84,7
	90	84,9
	90	84,1
$T=90^0C$	90	84,3
	90	84,1
	90	83,7
$T=100^0C$	90	83,9
	90	83,7

The results of the test affect the data obtained and then perform the calculations manually by formula and are also statistically analyzed with Microsoft Excel. The average yield of impact energy (E) at the highest temperature is 100ºC, ie 18,509 J and the minimum value for the non-curing sample is 12,375 J. The results for the average energy per unit area (W) with the highest grade are also when the heating temperature is 1000ºC, ie 0.1434 J/mm^2 and the minimum value for samples non-curing 0.0959 J/mm^2.

Several studies that have been conducted regarding the use of natural fibers by the method of post-curing reinforcement were increase tensile strength up to 40.26% of non-curing specimens [1],[4].

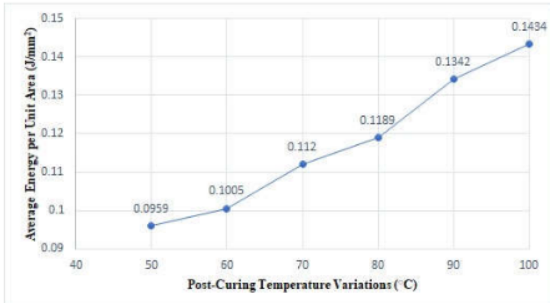

Figure 4 Graph of the relationship between the impact energy (E) on average by comparison post curing temperature variation and non post-curing

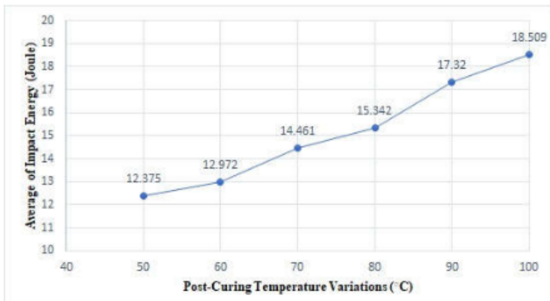

Figure 5. Graph of the relationship between the value of the impact energy per unit area (W) average temperature variation in the ratio post-curing and non-post-curing

4. Conclusion

The increase in impact strength in the average impact energy (E) and the impact energy per cross section (W) when you adjust the curing temperature of the heater is caused by the rise in temperature at Tg because the resin molecule reorganizes. The post-curing heating process can also increase the degree of crosslinking of the composite so that its mechanical properties are improved. The optimum strength value of the average impact energy sample (E) obtained at T=1000ºC is 18.50 J, while the minimum strength of the non-post-curing samples is 12.375 J. With the impact energy per cross section (W), even at T=1000ºC corresponds to 0.1434 J/mm^2 and the minimum non-curing sample value is 0.0959 J/mm^2.

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