# IZOD IMPACT TEST OF PALF REINFORCED POLYMERIC COMPOSITES*

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**Abstract**
Fiber reinforced polymeric composites have received widespread attention in the past four decades because of their high specific strength and modulus. In particular, research works have disclosed the potential advantages associated with the use of lignocellulosic fibers as the reinforcing phase in polymer composites (2-3). Among various natural fibers, pineapple leaf fibers exhibit excellent mechanical properties. The main chemical constituents of pineapple fibers are cellulose (70–82%), lignin (5-12%) and ash (1.1%). The superior mechanical properties of pineapple leaf fibers are associated with their high cellulose content (6). This work aims to make the analysis of the Izod impact energy against volume fraction of palf fibers of epoxy composites reinforced with PALF. The fibers were incorporated into the epoxy matrix with volume fraction from 0 to 30%. After fracture the specimens were macro photograph analyzed.
**Keywords:** Epoxy composites; Mechanical behavior; PALF; Fracture analysis.

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## 1 INTRODUCTION

Fiber reinforced polymeric composites have received widespread attention in the past four decades because of their high specific strength and modulus. Composites using high strength fibers such as graphite, Aramid and glass are commonly used in a broad range of applications from aerospace structure to automotive parts and from building materials to sporting goods. Lately, there has been a growing interest in the use of natural cellulosic fibers as the reinforcement for polymeric matrix. While these fibers may not be as strong as carbon and Aramid, their main advantages are low cost and biodegradability [1].
In particular, research works have disclosed the potential advantages associated with the use of lignocellulosic fibers as the reinforcing phase in polymer composites [2-3]. In addition to environmental benefits the lignocellulosic fibers present economic advantages, such as worldwide abundance and comparatively low costs as well as some technical properties associated with flexibility and toughness, which contribute to the performance of automobile components fabricated with natural fibers composites [4-5].
As fiber-reinforced composite structures are taking the central stage in almost every sphere of material science, lignocellulosic natural fibers like pineapple fibers (PALF) come as viable and abundant substitutes for the expensive and non renewable synthetic fibers. These with high specific strength improved the mechanical properties of the polymer matrix. In tropical countries, fibrous plants are available in abundance and at least some of them are agricultural crops. Pineapple is among them. PALF at present is a waste product of pineapple cultivation. Hence, without any additional cost input, pineapple fibers can be obtained for industrial purposes. Among various natural fibers, pineapple leaf fibers exhibit excellent mechanical properties. These fiber are multicellular and lignocellulosic. They are extracted from the leaves of the plant Ananus cosomus belonging to the Bromeliaceae family by retting. The main chemical constituents of pineapple fibers are cellulose (70–82%), lignin (5–12%) and ash (1.1%). The superior mechanical properties of pineapple leaf fibers are associated with their high cellulose content [6].
Since the heterogeneous characteristics of lignocellulosic fibers is a limitation for their use in composites, the present work carried analysis of mechanical behavior on tensile strength of composites of polyester reinforced with PALF.

## 2 EXPERIMENTAL PROCEDURE

Palf fibers from the as received lot were cleaned and dried at room temperature. After separation, cleaning and drying at room temperature, the palf fibers were mixed in amounts of o, 10, 20 and 30% by volume with insaturated epoxy resin to prepare the composites. Plates of the composites with 10 mm thickness were fabricated in a rectangular steel mold with dimensions of 152 x 125 mm. The fibers were maintained aligned along the dimension of 125 mm, corresponding to the final length of the test specimens. The fabrication procedure was the following. The still liquid epoxy resin DGEBA, with TETA as hardener, was poured onto the palf fibers inside the mold. The composite thus formed was allowed to cure for 24 hours at room temperature. The plate of each different composite was then cut according to the direction of fiber alignment in bars measuring 10 x 62,5 x 12,7 mm. These bars were used for preparation of samples for Izod Impact test, according to ASTM D256.

The samples were impact tested in a PANTEC pendulum with IZOD configuration. The impact energy was obtained using an 15 J power hammer for composites with 0, 10, 20 and 30 % of fibers. For each volume fraction of fibers, 18 specimens were used for statistical validation.

## 3 RESULTS AND DISCUSSION

Table 1 shows the results of the values of izod impact energy, with their respective standard deviations for pure epoxy and composites, with different volume fractions of palf fibers.

**Table 1** – Energy impact Charpy for epoxy matrix reinforced with palf fibers

| Palf Fibers (%) | Impact Energy (J/m) |
|---|---|
| 0 | 18 ± 1,8 |
| 10 | 120 ± 59,32 |
| 20 | 197 ± 76,65 |
| 30 | 503 ± 116,22 |

Based on the results of Table 1, the Izod impact Energy variation with the fraction of palf fibers is shown in figure 1.

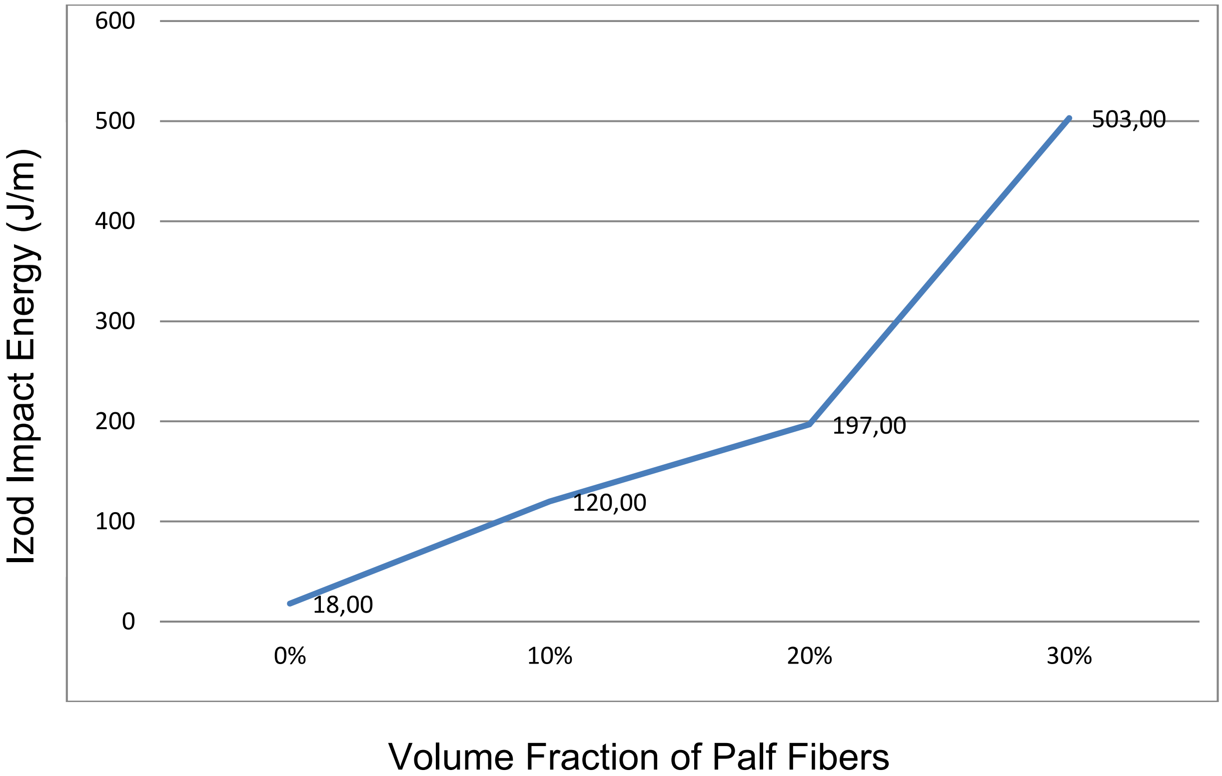


**Figure 1** - Izod impact energy as a function of the amount of palf fibers

One should notice the marked increase in Izod impact energy with the fiber volume fraction of palf, as shown in figure 1. It is also important to note that the error bars present the standard deviation, a common feature for lignocellulosic fibers. This is due to the heterogeneous nature of natural fibers, resulting in substantial dispersion properties of the composites reinforced by them.

The incorporation of continuous and aligned palf fabrics results in a marked change with respect to pure epoxy matrix (0% fiber) in which a totally transversal rupture occurs. Even with 10 wt. % of fiber, the rupture is no longer completely transversal. The crack nucleated at the notch will initially propagate transversally through the epoxy matrix, as expected in a polymer. However, when the crack front reaches a fiber, the rupture will proceed through the low strength interface. As a consequence, after the Izod hammer hit the specimen, some fibers will be pulled out from the matrix but, owing to their flexural compliance, the palf fabric will not break but simply bend. In fact, the specimens containing palf fabric above 10 wt. % are not separated at all as seen in Figure 2, which shows the aspect of new palf fiber Izod specimens after the impact test. For these amounts of continuous and aligned palf fabrics, part of the specimen was bent enough to allow the hammer to continue its trajectory without carrying away the top part of the specimen, as expected in an Izod test.


**Figure 2 -** Macrophotograph of Izod impact tested specimens with different amounts of continuous and aligned palf fabric - epoxy composites

It should be noted that the value of the impact toughness in the specimens not completely separated cannot be compared with others in which the specimen is totally split apart, since it underestimates the impact toughness. In other words, had all the fibers been broken, the adsorbed impact energy would have been even higher.

## 4 CONCLUSIONS

Selected PALF significantly improve the izod impact energy of epoxy matrix composites. The incorporation of continuous and aligned palf fabrics results in a marked change with respect to pure epoxy matrix (0% fiber) in which a totally transversal rupture occurs. The crack nucleated at the notch will initially propagate transversally through the epoxy matrix, as expected in a polymer. However, when the crack front reaches a fiber, the rupture will proceed through the low strength interface. As a consequence, after the Izod hammer hit the specimen, some fibers will be pulled out from the matrix but, owing to their flexural compliance, the palf fabric will not break but simply bend. The specimens containing palf fabric above 10vol. % are not separated.

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