Journal of Inventive Engineering and Technology (JIET)
ISSN: 2705-3865
Volume-4, Issue-2, pp-83-86
www.jiengtech.com
Research Paper Open Access

Raffia Nut Powder Reinforcing Filler in Unsaturated Polyester Resin

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ABSTRACT: *The study determined the degree of reinforcement that is attainable with different percent composition of different particle sizes included 150µm, 180µm, 300µm, 425µm. And the percentage composition used were 5%, 10%, 15%, 20%, 25% for each of the resultant composite, the mechanical property was tested. The tensile test revealed an increase in tensile strength to the point of 20% filler reinforce at which it begins to deteriorate. The tensile strength of the reinforced composite is greater than the unreinforced, the aim of achieving high strength, and reducing the volume of the polyester used, and reduction in cost of production were all achieved.*

KEYWORDS*:* *Raffia Nut Powder, Filler, Unsaturated Polyester Resin, Tensile strength.*

Date of Submission: 25-11-2023 Date of acceptance: 29-11-2023

I. INTRODUCTION

The invention of composite material has dated back to the mid nineties and since then has provided man with a wider range of materials to select from. The use of natural organic materials (fillers) which are abundant in our environment to form a composite of continuous or discontinuous fibrous or particulate materials embedded an organic matrix which will serve as glue, will yield a composite with better mechanical properties (Vigneswaran et al., 2015; Ekwedigwe et al., 2023).

The global demand for fillers including calcium, talc, glass fibre, mica, aramid, carbon, wallostone, aluminium, trihydrate for the plastic industry is estimated to be 15million tons. Recent statistics (2002) shows a demand for performance minerals (fillers) for se in the plastics industries North America to be about 4 millions per annum with an annual average growth of 4.2% (Idris et al., 2015; Nwambu et al., 2023).

The first generation of fillers which include talc powder and asbestos fibres were used for their beneficials effects on stiffness and heat resistance, the quest for a replacement of asbertos due to health purposes led to the use of calcium carbonate particles and mica flakes (Ekwedigwe et al., 2023; Okoye et al., 2023). Calcium carbonates was found to increase impact strength while mica was found to increase stiffness and heat resistance. Wallostone increases hardness, hallow glass spheres lowers density and a combination of glass fibres with particulate fillers provides unique properties that cannot be attained with single filler (Li et al., 2015). Flexural modulus and heat resistance are the two critical properties enhanced by the inclusion of performance minerals (fillers). They have found usage in the building/construction industry-automotive exterior, transportation, furniture making-outdoor furniture, electrical and electronic-electrical connectors, packaging-microwaveable containers (Achebe et al., 2019; Ezenwa et al., 2019).

The study aimed to use natural resource that are abundant within our environment such as raffia nut powder, to impact more strength to the final product. Another important factor in this research is the reduction in cost, by replacing a portion of the polyester which is not abundant with a material that is much cheaper and available. This research work will also provide information on how much the mechanical property is improved with respect to particle size variation and distribution and will therefore suggest where raffia nut fillers can be applicable in our manufacturing industries.

II. MATERIALS AND METHODS

The materials used comprises of unsaturated polyester resin, accelerator (cobalt diethyl hexanoate), parting agent (vegetable oil), Moulds and raffia nut powder sourced from the river banks of ose in Oba, Anambra State, Nigeria.

The filler was gotten by debarking of the nut followed by removal of the reddish-brown skin layer and the drying. When properly dried they were grounded in to powder and sieved into different particle sizes, using the British standard sieve shaker in the foundry shop of Nnamdi Azikiwe University, Awka, Nigeria. The powder was sieved into sizes like 150um, 180um, 300um, 425um. A digital weighing balance was used to weigh out the required quantities in gramme. Chemical analysis conducted on Raffia nut powder at PRODA revealed different parameters such as Holocellulose 45.16%, Lignin 18.05%, Carbohydrate 29.77%, Protein content 2.58%, Fat and oil 3.85%, Crude fibre content 32.6%, Ash content 17.2% and water content 13.8%. The split mould made of mild steel with length = 150mm, height = 10mm and width = 25 mm. the mould was properly coupled in order to prevent shift or mismatch. The parting agent was applied and allowed to dry for some minutes.

The polyester resin was poured into the mixing cup and the mixture properly stirred. The stirring helps to increase the surface area of contact between the polyester resin and the accelerator, which leads to the provision of ready bond spacing to take up the reinforcement. After the stirring and ensuring proper mixture of the two liquids, then the appriopate percentage of the raffia nut powder was added and stirred further before addition of catalyst for curing reaction. After curing, the mould is uncoupled and the composite is released, before cooling processes were carried out at atmospheric temperature and pressures. The samples that were tested for tensile test had the following parameters (150x15x10)mm.

III. RESULTS AND DISCUSSIONS

Table 1.: Results of samples reinforced with different particle size with different percentage composition

%Composition of particle	**Tensile Strength N/mm^2**			
	150um	180um	300um	425um
5	165	160	156	152
10	192	184	176	168
15	217	208	200	188
20	236	228	220	208
25	220	217	208	200

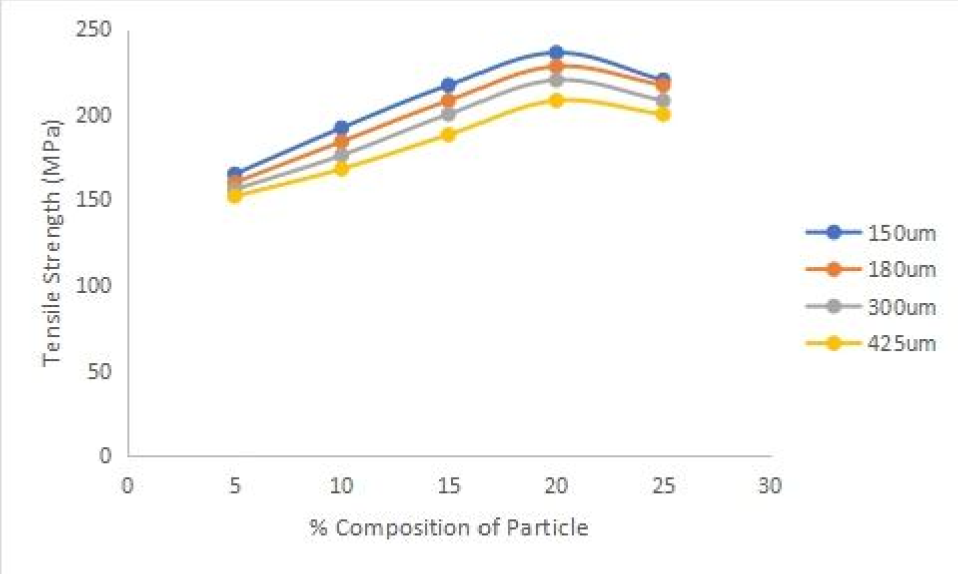

Figure 1.0. Result of tensile strength against the % composition of particle.

Several composites consisting of resins and raffia nut powder were produced but they differ from each by their percentage composition and particle size as shown in the Table 1. Amongst all the samples that were produced for this experiment, it was observed that the samples containing 150µm, gave the highest tensile strength, compared to the control specimen (unreinforced specimen). The tensile strength of the unreinforced was found to be 65MPa, and in the presence of fillers the tensile strength was observed to have increased marginally.
From Fig. 1, it was observed that the tensile strength of the samples reinforced with 150µm was found to have the highest strength. Amongst the five samples reinforced with 150µm, the sample reinforced with 20% of the filler was observed to have the highest tensile strength. A decline in the tensile strength was noticed in the 25% filler reinforced composites. It virtually depicts that in producing a composite with raffia nut powder, an increase in strength is observed with a decline in particle size and an increase in percentage composition to a maximum of 20%. The results indicate that a better distribution of filler is attainable with smaller particle size and a percent composition as much as 20%. This is possible because a good transmission of stress is therefore attainable, the stress is properly shared within the particles and also due to good distribution initiation of fracture will be quite difficult (Achebe et al., 2019; Ekwedigwe et al., 2023)

From Figure 1, it was noticed that there is an increase in tensile strength as the tensile strain increases. This could be as a result of the decrease in brittleness of the specimen as the filler content increases, as it was observed that the unreinforced sample had a very brittle fracture. The extension of the respective specimens were related to the filler content (weight %). It was noticed that the extension increased geometrically as the filler content increases. This phenomenon might be due to the filler abilty to transfer energy within themselves, thus more fillers, more energy transfer which definitely leads to an increase in extension (Atuanya et al., 2014; Ezenwa et al., 2019).

IV. CONCLUSION

It is evident that grinded raffia palm fruit can be used as filler to increase the tensile strength of the composites. However, these samples produced were found to contain some defects. The defects that were observed include surface flaws, lack of homogeneity in the distribution and concentration of the fillers. These defects surely would have contributed some errors in the result obtained.

Conflict of Interest Statement

- The authors declare no conflict of interest in this manuscript.

Data Availability Statement

- The data that support the findings of this study are availability on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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