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Mechanical properties of cashew nut shell powder (CNSP) filled natural rubber vulcanizate

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ABSTRACT

Natural rubber was reinforced with cashew nut shell powder (CNSP) at 0, 10, 30 & 50g respectively, with particle size of 450μm. the cured samples were evaluated for tensile strength, hardness, and abrasion resistance, also evaluated were pH and moisture content. The pH result revealed cashew nut shell powder as an acidic filler with pH of 4,97 and moisture content of 0.72%. There was increase in hardness as the filler loading were increase for 0-50g. Similar result was obtained in the abrasion resistance, as the filler loading were increase the percentage abrasion was reduced, but it was no so for the tensile strength, the sample filled with 50g of CNSP revealed the best tensile strength while that filled with 30g CNSP revealed the poorest compared with the control sample.

KEYWORDS

Cashew nut shell powder;
Natural rubber;
Particle size;
Hardness;
Tensile strength.

INTRODUCTION

This research work aims at developing new applications for cashew nut shell (CNS) in the polymer field. Cashew is widely cultivated in the tropics and the nut is a very proteineous tasty product popular throughout the world. Cashew nut shell (CNS) is an Agricultural by-product that is underutilized.

In the Konkan region of India, the cashew (*Anacardiumaccidentale L)* is one of the major horticultural crops. India is the largest producer, processor, exporter and second largest consumer of cashew in the world.

The shell of cashew comprises of 50% of the weight of the raw nut, the kernel represent 25% and the remaining 25% consist of the natural cashew nut shell liquid (CNSL).

The different types of additives used in the processing of rubber materials include : vulcanizing agents, accelerators, activators, antidegradant, softeners, fillers, colorants, etc. Some of these additives could be incorporated into the polymer matrix in large quantity while others in minute quantity[10].

Filler is one of the major additive used in natural rubber compound, it is the second largest that is incorporated into a polymer and has a marked effect

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TABLE 1 : Formulation table

		PPHR			
S/NO	**INGREDIENTS**	**1**	**2**	**3**	**4**
1	Natural rubber	100	100	100	100
2	Zinc oxide	5	5	5	5
3	Stearic acid	2	2	2	2
4	Trimethylquinoline	1.5	1.5	1.5	1.5
5	Cashew nut shell powder	00	10	30	50
6	MBTS	3	3	3	3
7	sulphur	3	3	3	3

and influence on the rubber material. Generally, filler function to modify the physical and chemical properties of a vulcanisate, improve processing and reduce cost.

In the rubber industry, fillers that are commonly in use are carbon black, china clay and calcium carbonate. Carbon black is derived from petrochemical sources, however the unstable price of crude oil has led to the research for fillers that are derived from other sources. Thus fillers from mineral and organic sources have been developed to replace some grades of carbon black. On account of their low cost and availability in large feed stock agricultural by-products e.g. maize cob, plantain peel, rice husk, cassava peel, groundnut shell, cocoa nut shell, and sugar cane bagasse, which have been estimated at more than 200,000 metric tons per annum, represent an under-utilized renewable resources[15].

There is therefore the need to develop fillers from other sources particularly from renewable resources to replace some grades of carbon black.

EXPERIMENTALS

The cashew nut shell were gotten from Auchi, in Edo state and were carefully sorted out from other debris and was taken to a grinding machine, after grinding the filler was sieved to 450µm. The following materials were compounded using a laboratory size two roll mill sequentially as appeared on the formulation table.

RESULTS AND DISCUSSION

Results

TABLE 2 : Characterization of cashew nut shell powder

Parameter	Cashew Nut Shell Powder
pH	4.97
Moisture content (%)	0.72

TABLE 3 : Hardness test result (IRHD)

S/no	Filler loading (g)	Hardness
1	0	38
2	10	40
3	30	43
4	50	47

TABLE 4 : Abrasion resistance result (%)

S/no	Filler loading (g)	% abrasion
1	0	28.57
2	10	25.22
3	30	20.55
4	50	25.32

TABLE 5 : Tensile strength (Mpa)

S/no	Filler loading (g)	Tensile strength (mpa)
1	0	13.00
2	10	12.30
3	30	16.30
4	50	10.20

DISCUSSION OF RESULTS

The filler pH reveals that cashew nut shell powder (CNSP) is acidic with a pH value of 4.97(see TABLE 2), it is generally known that acidic fillers retards vulcanization (prolong cure time) while alkaline fillers accelerates vulcanization (reduce cure time).

The moisture content of filler is often used to predict the degree of defects arising from shrink-

age during curing, particularly for products processed at elevated temperatures. The result obtained reveals that moisture content of the cashew nut shell powder (CNSP) is 0.72% which is considerably good and negligible compared with other organic filers.

Hardness as measured in this study is the relative resistance of the surface of samples to indentation by an indentor of specified dimension under a specified load. Table reveals that as the filler loading increases, the resistance to hardness also increases, this result is expected because as more filler gets into the matrix of the rubber compound, the elasticity of the rubber chain reduces, resulting to a more rigid vulcanizate. The same trend has earlier been reported by Ishak and Bukar when rice husk was used to reinforce natural rubber.

Gravan defined abrasion as the unwanted progressive loss of substance from the surface of a body brought about by a mechanical action from the rubbing of one surface to another. The abrasion of filled polymer depends on the relative particle nature of the filler, the abrasive size, type of filler, the nature of the interface and the strength of adhesion between phases[17]. Abrasion resistance is higher (low wear) when the filler particle is larger and if the adhesion between the filler and the polymer matrix is good. The result in TABLE 4 reveals that as the filler loading is increased, the percentage abrasion reduced (low wear).

The tensile strength of a material which is the force per unit of the cross sectional area at the point of rupture of a specimen as a result of the strain applied. It is used to determine the compound susceptibility to deterioration by oil, heat, weather, e.t.c. It also determines if the product has been properly vulcanized, the ingredients thoroughly blended and the mix kept away from foreign matters. Form the results in TABLE 5, a better tensile strength is reveal on sample filled with 50g of CNSP and followed by that of 10g, it was poorer in the sample filled with 30g of CNSP, this may be attributed to the poor mixing or uneven dispersion of the filler in the compound mix.

CONCLUSION

Generally, when the results obtained are compared to the unfilled sample, the properties of the filled are better compared to the unfilled which is an indication of reinforcement of the filler (CNSP) hence will be an alternative filer to the commercially available reinforcing fillers for rubber compounding.

RECOMMENDATION

The work has revealed some essential properties of CNSP as renewable filler in rubber compounding. The following recommendation has been made:

More particle size of the filler should also be used to determined how particle sizes can affect the mechanical properties

A wide range of filler loading should as well be used to establish the best loading at various related properties.

Rheological analysis is also recommended for this material as it is a new filler to how it affects the cure rate as the filler is acidic in nature.

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