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Effect of sugar cane bagasse particle size on natural rubber compound for the production of floor mat

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ABSTRACT

Natural rubber crumb was reinforced with sugar cane bagasse in various proportions (30g, 45g and 60g) and particle size (120 μm). The samples obtained were evaluated for physico-mechanical properties which included tensile properties, hardness, compression set and abrasion resistance. The studies revealed that sugar cane bagasse is slightly acidic and is non-black semi-reinforcing filler when compared with the blank sample and estimated standard results of natural rubber. The abrasion test revealed that increase in filler loading reduces the abrasion resistance, i.e. increases the percentage wear of the material. The tensile properties revealed a better result at filler loading of 30g followed by that of 60 and the least with that of 45g, and for compression set, increase in filler loading showed little or no difference in the result.

KEYWORDS

Natural rubber crumb;
Sugar cane bagasse;
Abrasion resistance;
Compression set.

INTRODUCTION

Natural rubber and synthetic rubber are converted to serviceable products by combining them wilh fillers[1]. Fillers are materials which when added to rubber mix enhance the properties. These properties are physical in nature which include hardness, tensile strength. flex fatigue, stiffness and to some extent. the chemical properties[1]. Fillers improve the processing characteristics, reduce cost and also acts as auxiliary components necessary for vulcanisate.

Fillers can either be reinforcing, semi-reinforcing or non-reinforcing. Reinforcing fillers enhance the physical properties of the cured article. An example of these is carbon black. In 1905, S.C. Note discovered that fine particulate carbon black included in rubber used on the outer part of a tyre almost doubled the lifespan of the tyre.

There are also non-reinforcing fillers. They reduce cost and improve processing characteristics for example by reducing nerve in the processing of rubber. Non-reinforcing fillers have little or no effect on the physical properties of the rubber[8]. They act as cheapener by increasing the bulk of the products. Examples of these include talc, barites, mica powder, whiting and china clay.

Semi-reinforcing fillers are partially reinforcing. These include soft clay, calcium carbonate and antimony.

Sugar cane chaff is waste the is chewed from sugar and if discarded and start decaying, it attracts insects such as flies. If decaying in a moist environment, produces an unpleasant smell or odour which attracts insects (flies).

Though the cane fibre does not get decayed easily, if it is in a very dry environment, the water is being evaporated by heat leaving the fibre dry, and after some days, it begins to form crumps, with these expression above, if sugar cane fibre is being preserved well as earlier stated, it could serve as filler in the compounding of natural rubber (NR) when properly grind and sieved, this will make it useful and no longer a waste and hazard to health and the environment.

The aim of this work is to assess the effects of blending sugarcane bagasseon properties of naturalrubber vulcanisate. This is with a view to reduce product cost.

MATERIALS AND METHODS

Crumb grade of natural rubber was obtained from Integrated Rubber Products Plc. Benin, The sugar cane chaff was obtained from samaru environ in Zaria. It was dried, grinded and sieved to particle size. Zinc oxide, stearic acid,trimethylquinoline (TMQ), mercaptobenz olethiazolesulphenamide (MBTS), sulphur,and processing oilwere sourced from Integrated Rubber Products Plc. BeninCity.

SAMPLE PREPARATION

The sugar cane chaff was characterized. The value of the pH, and moisture content of the sugar cane chaff were determined. (See TABLE 1).

Allthesamples of thefillerblendswere prepared followingtherecipesin TABLES 2.

TABLE 1: Characteristics of sugar cane chaff

Parameter	Sugarcane Bagasse
pH (%)	6.14
Moisture content (%)	0.95

TABLE 2 : Standard rubber formulation

Formulation: nr filled with s.c.c with particle size (120um)

S/NO	INGREDIENTS	1	2	3
1.	Natural Rubber	100	100	100
2.	Zinc oxide	4	4	4
3.	Stearic Acid	2	2	2
4.	TMQ	1.5	1.5	1.5
5.	Sugar cane bagasse	30	45	60
6.	MBT	2	2	2
7.	Sulphur	2.5	2.5	2.5
8.	Processing oil (paraffinic)	1	1	1

Batch factor = 3

Compounding of theformulations was carriedout on a standard laboratory rollmillin accordance with A SIMD3I32 procedures. Sample moulding and curing was done on an electrically heated laboratory moulding press to optimum cure state.

Assessment of vulcanisate properties

The tensile strength, hardness, and abrasion tests were carried out using the standard methods.

RESULTS AND DISCUSSION

Physico-mechanical properties of samples

TABLE 3 : Hardness test result (irhd)

S/NO	PARTICLE SIZE (μm)	FILLER LOADING(g)			
		0	30	45	60
1	120	39	46	50	49

TABLE 4 : Abrasion resistance test result (%)

S/NO	PARTICLE SIZE (μm)	FILLER LOADING (g)			
		0	30	45	60
1	120	0.91	2.98	3.37	3.72

TABLE 5 : Tensile stress result (N/m^2)

S/NO	PARTICLE SIZE (μm)	FILLER LOADING (g)			
		0	30	45	60
1	120	4.4×10^5	3.6×10^5	5.5×10^4	1.9×10^5

Discussion of results

The pH of the filler slurry shows that the filler (sugarcane bagasse) with pH of (6.5) is slightly acidic. It is generally well known that acidic fillers retards the cure rate (longer cure time) while alkaline filler accelerates cure rate (shorter cure time).

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. It is generally known that filler increases the hardness of a material. The hardness results as shown on TABLE 3 indicates that the higher the filler loading the better the hardness, irrespective of the particle size of the filler, This result is expected because as more filler gets into the rubber, the elasticity of the rubber chain is reduced resulting to a more rigid vulcanisate.

Gavan 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 against another, the abrasion of filled polymers depends on the relative size of the filler particle, the size of abrasion, types of fillers, the nature of the interface and the strength of adhesion between the phases. Abrasion resistance is higher (low wear) when the filler particles are larger compared to the size of abrasive particles, if the adhesion between the filler and matrix is good.

The result in TABLE 4 indicates that the abrasion resistance of the vulcanisate decreases marginally as the increasing filler loading. The marginal decrease in abrasion resistance with increasing filler concentration may be that as filler loading increases, the strength adhesion between the polymer and filler decreases. A situation may have been reached were there is no enough polymer to wet (bond) the filler to the polymer phase, i.e adhesion between the filler and the polymer matrix is not good enough. The tensile strength result as shown in TABLE 5 indicates that there is decrease in the tensile strength as the filler loading increases.

CONCLUSION

Comparing the reinforcing properties of the vulcanisate of the filled and unfilled, the properties of the filled are better than the unfilled samples, which is an indication of reinforcement of the sugarcane bagasse and as well can be classified as a semi-reinforcing filler.

However, due to the target of this research work, which aimed at the production of a foot mat with necessary properties such as abrasion resistance and compression set, having sample with the best abrasive property as the filler loading decreases. The mechanical properties of the vulcanisate are a function of particle size and filler loading. It was found out that the agricultural by-product is slightly acidic with low moisture content.

RECOMMENDATION

This research work has revealed certain properties of the sugar cane bagasse. In order to modify and establish these findings, the following recommendations have been put forward from some of the problems encountered:

(i) Sugar cane bagasse powder should be used in the manufacture of molded rubber products such as foot mat, shoe sole, floor tiles that requires less tensile stress during service life because of the inherent reinforcing properties in them.

(ii) Sugar cane bagasse powder may perfectly serve as an extender or diluents i.e. to increase the bulk with corresponding lightness in weight of the polymer product with a reduction in cost.

(iii) Sugar cane bagasse powder values for hardness obtained may not be used to design products for rubber mounts instead be employed in hard casing like battery case.

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