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An Investication on the Potential of Palm Karnel Husk as Fillers in Rubber Reinforcement

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Abstract: The Palm Kernel Husk (PKH) was characterized in terms of Ph, moisture content, loss on ignition, surface area and conductively. The palm kernel husks were incorporated into natural rubber using a laboratory size two roll mixing mill. Curing using Semi-efficient vulcanization (semi-Ev) was chosen. The scorch time, cure time and torque values of natural rubber compounds were determined at 185°C as a function of filler loading using Monsanto rheometer. The physical testing of the natural rubber vulcanization involves the determination of tensile strength modules at 100% elongation, elongation at break, hardness, abrasion resistance and compression set of the natural rubber vulcanizates were determined and compared with the values obtained for vulcanizates with commercial carbon black (N330). The commercial carbon black filter exhibition the best over all vulcanizates properties as compared to palm karnel husk especially with regard to tensile strength and modules at 1000%.

Key words: Palm kernel husk • natural rubber filler • vulcanizate semi efficient vulcanization and characterization

INTRODUCTION

Filter is one of the major additives used in natural rubber compound and has marked effect and influence on rubber materials filler functions to modify the physical and to some extent the chemical properties of vulcanizates [1].

Particulate fillers are added to rubbers either to extend and cheapen the rubber compound, or to add desirable qualities to the final compound and enhance the products' service qualities [2].

In rubber industry, fillers that are commonly in use are carbon black, China clay and calcium carbonate. Carbon black is derived from petro-chemical sources but the unstable price of crude oil has led to the search for fillers that are derived from other source [3], agricultural by-products: maize cob, cocoa pod, rice husk plantain; peel etc. are low cost materials for readily available in large quantity `for use everywhere of which well over 300 millions tones are produced annually [4].

In previous reports, the use of cocoa pod husk, rubber seed shells [5] Plantain peels etc were examined. In this present studies, the effect of palm kernel husk on the cure characteristic, Physic-Mechanical properties of natural rubber vulcanizates are examined.

MATERIALS AND METHODS

Materials: Crumb natural rubber, which conforms to technically specified Rubber (TSRIO) but usually NSRIO show as Nigeria standard Rubber was obtained from Iyayi Rubber Factory Egba, Benin City Edo State. The rubber compounding chemicals such as zinc Oxide, Stearic acid, processing oil, N330 carbon black, sulphur mercaptobenzothioxole sulphanamide (MBTS) and tetrameyhyl thiuran disulphide (TMTD) were of commercial grades. Coconut fibre was obtained from Ihievbe in Edo State, Nigeria.

Filler preperation: Large quality of palm kernel husk was obtained from the palm oil mill at Ihievbe. They were washed in hot water and KOH remove as mush water as possible. They were sun dried in an oven at 170°C. The kernel husk was ground into fine powder using electric milling machine for corn, cassava and yam flour etc. the ground palm kernel husk was therefore sieved with a mesh sieve of size 212 mm and retain by a BONM mesh size.

Compounding: The recipe used in the formulation of the natural rubber compound is given in Table 1. Mixing was carried out on a Laboratory two-roll mill in accordance

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Table 1: Recipe for compounding the natural rubber mixes

Ingredient	Parts Per Hundred (PHR)
Natural rubber	100
Filler	0-70 0-70
Zinc oxide	4.0
Stearic acid	2.0
Sulphur	1.5
Processing oil	20

with the method described in the American society for Testing and materials (ASTM-D3184-80).

Cure characteristics: The cure characteristic of the compound mixes were measured at 175°C on an oscillating Disc Rheometer (ALPHA ODR 2000) in accordance with the 150 3417 method.

The cure time t_{90} torque (minimum torque (t_{min}) and maximum t max) were determined from the rheographs. The cure rate and ODR torque were determined using the expression.

$$\text{Cure rate} = \frac{100}{T_{90-t2}}(S^{-1})$$

$$\text{ODR torque} = \frac{90\,t_{max} - t_{min} +_{min}}{100}$$

Physico-mechanical properties

Tensile strength: The text specimens were molded in an electrically heated press at conditions predetermined from the rheographs. Tensile properties of the vulcanizates were measured with a Monsato Tensile Tester (Mode 1/m) at cross-head speed of 500 mm min^{-1} using dumb bell test specimens (type H) as contained in ASTMD-412-87 (METHOD A). the tensile strength at break was calculate ad the elongation at break.

Compression set: Wallace compression set machine (mode/Ref No (2, H_2^{50}) was used to determined the compression set of the vulcanizates.

$$\text{Comprsssion set } \% = \frac{t_0 - t_r}{to} \times 100$$

Hardness test: The hardness test of a rubber is the relative resistance of the surface to indentation by an indentor of specified dimension under a specified load Hardness of the vulcanizates was determined by standard dead load method (BS903 part A 26).

Abrasion resistance: Wallace Akron tester was used in accordance with BS method

$$\text{Abrasive resistance index} = (S)\frac{1000}{T}$$

RESULTS AND DISCUSSION

Characterization of palm kernel husk in terms of the moisture content, pH, surface area and loss on ignition is shown in Table 1

Physical and chemical properties of palm kernel husk

Parameters	
Moisture content	10.0
PH of slurry	5.92
Surface area (CM^3)	0.01
Loss on ignition (%)	96.6

Figure 1-3 show typical scorch time-filler loading, cure time filler loading and maximum torque filler loading curves of palm kernel husk and carbon black filled natural

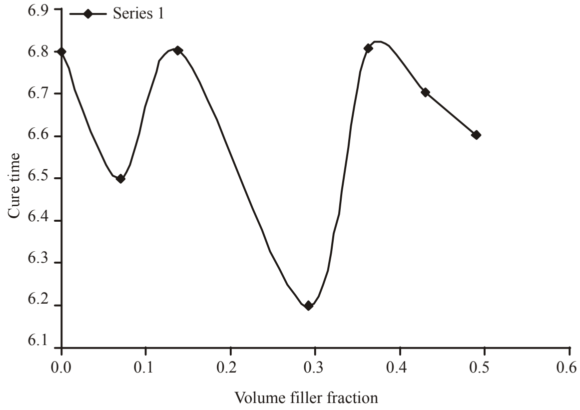

Fig. 1: Cure time (t90) curve of palm kennel husk filled with vulcanizates

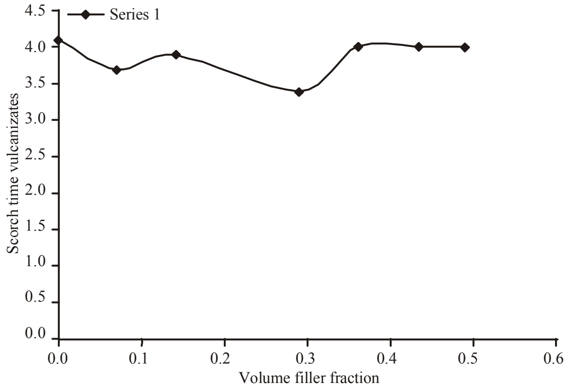

Fig. 2: Scorch time curve for palm kennel husk filled vulcanizates

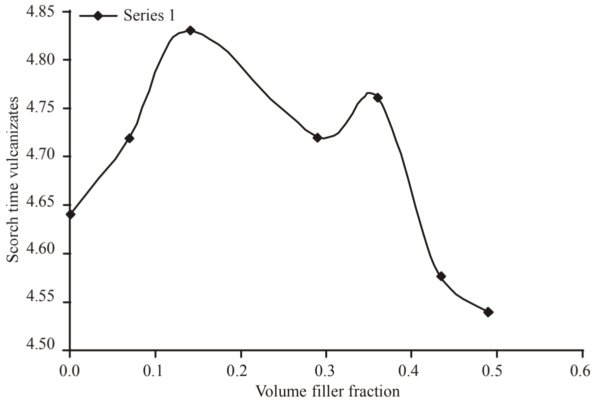

Fig. 3: Maximum torque curve for palm kennel husk filled vulcanizates

rubber vulcanizates respectively. Analysis of the various curves facilitates the determination of the various cure related parameters.

It is know that in the case of filler vulcanizates, the efficiency of the reinforcement depends on a complex interaction of several filler related parameters. These include particle size, particle shape, particle dispersion, surface area, surface reactivity, structure of the filler and the bonding quality between the filler and the rubber matrix [6]. Hepburn [7] has pointed out that a good reinforcing fillers should posses a small particle size that is <1000 nm, a chemical active surface and a surface which is both porous and very irregular in sharp to maximize surface irregular in shape to maximize surface content between rubber and filter.

The t_{90} and scorch time of palm kernel husk filled vulcanizates exhibit a retardation with increasing palm kernel husk content, while the maximum torque increases with the increasing filler content, that is it shows enhancement in cure rate.

The difference trend observed in the cure characteristics of the filled vulcanizates may be attributed to differences in the filler properties. The cure enhancement observed in the case of palm kernel husk-filled vulcanizates can be associated to the filler related parameters such as surface area, surface reactivity particle size and moisture content. In general, a faster cure rate is obtained with fillers having a low surface area and high moisture content [8]. Butler and Freakley [9] reported that cure rate is directly related to the humility and water content of the rubber compound. However, in this present study, the most probable factors to account for the observed cure enhancement of palm kernel husk fillers are high moisture content, lower surface area and large particle size [10].

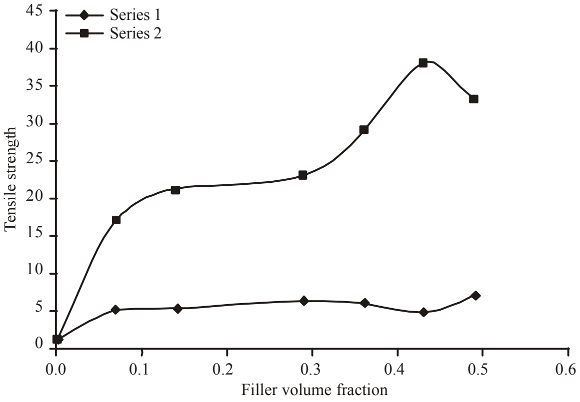

Fig. 4: The effect of filler loading on tensile strengths of palm kernel husk and carbon black filled natural rubber vulcanizates

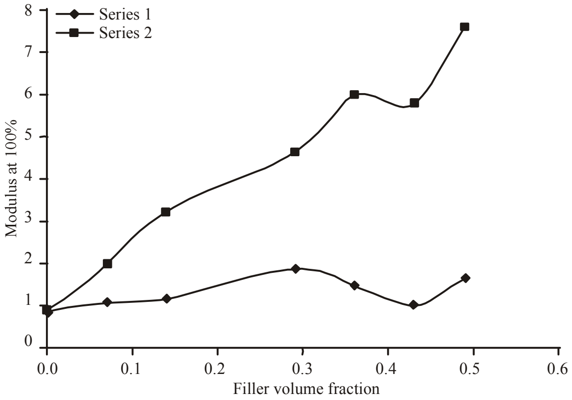

Fig. 5: Effect of filler loading on modulus at 100% of palm kernel husk and carbon black filled NR vulcanizates

For carbon black-filled vulcanizates, the cure retardation may be due to having a smaller particle size, therefore is more surface area available for chemical interactions during vulcanization. Earlier studies by Patterman [11].

Indicated that with commercial fillers, cure retardation is directly proportional to the total surface area of fillers.

Figure 4-9 summarizes the physical properties of palm kernel husk and carbon black N330-filled natural rubber Vulcanizates

The tensile strength Fig. 4 and modulus at 100% elongation Fig. 5 of palm kernel husk filled natural rubber compounds are markedly lower by about 4 fold than the values obtained for N330-filled natural rubber vulcanizates.

High tensile strength and modules values and low values of elongation at break Fig. 6 are frequently attributed to chemical cross-links produced in the

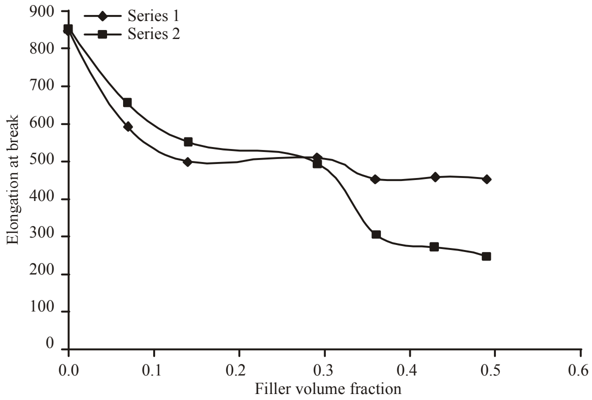

Fig. 6: Effect of filler loading on elongation at break of palm kernel husk and carbon black filled NR vulcanizates

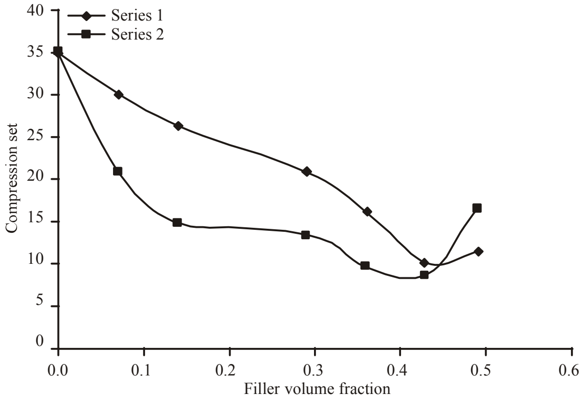

Fig. 7: Effect of filler loading on compression set of palm kenel husk and carbon black filled NR vulcanizates

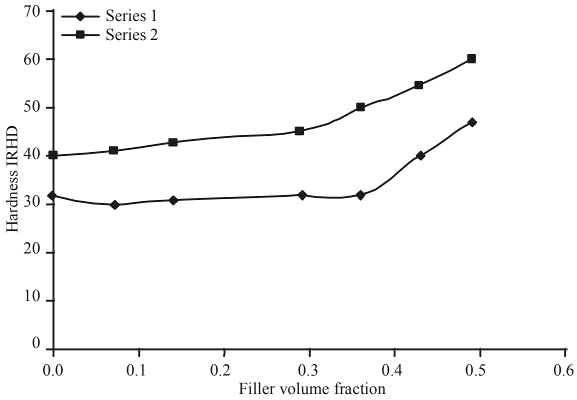

Fig. 8: Effect of filler loading on hardness of palm kernel husk and carbon black filled NR kulcanizates

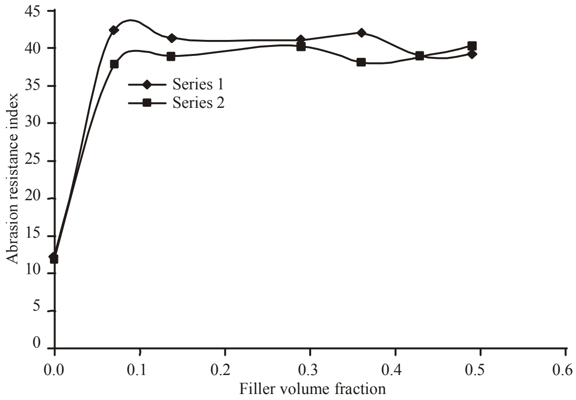

Fig. 9: Effect of filler loading on abrasion resistance of palm kernel husk and carbon black filled NR vulcanizates curves

vulcanizates and are indices of strong filler-rubber matrix interaction [12]. The tensile strength and modules at 100% elongation increased with increasing filler content until a maximum level is reached as shown in Fig. 4 and 5.

A further increase in filler loading reduces the respective properties. As the filler loading is increased, eventually a level is reached whereby the filler particles or aggregates no longer adequately separated or wetted by rubber phase. Carbon black filler vulcanizates exhibit a much higher tensile strength and modules at any particular loading of fillers. The superior tensile strength and modules at 100% elongation of the N330-filled vulcanizates implies that apart from its smaller particle size, there are other factors such as filler dispersion, surface reactivity and bounding quality between the fillers and natural rubber matrix [13]. The hardness of both carbon black and palm kernel husk filled vulcanizate increased with increasing filler loading as shown in Fig. 8. This result is expected because as more fillers particles get into the rubber, the elasticity of the rubber chain is reduced, resulting in more rigid vulcanizates.

The abrasions resistance Fig. 9 showed an irregular pattern of increased with increasing filler content for both fillers. This indicates that filler loading is not a function of the measured parameters. This observation may therefore be attributed to the degree of dispersion of the filters. The compression set results as shown in Fig. 8, the unfilled system had the largest compression. As filler loading increases, the compression of filled vulcanizates decreases. The vulcanizate filled with carbon black N330 exhibit least compression from 10% to 60% filler loading. The compression set for palm kernel husk filled vulcanizates became least at 70% to 100% filler loading. The observation is due to amount of filler incorporated into the matrix, the degree of dispersion of the fillers and its particle size.

CONCLUSIONS

The main aim of this work is to gauge the possibility of utilizing the low cost agricultural waste as alternative filler material in tuber reinforcement. The preliminary results show that palm kernel husk is potential reinforcing filler for natural rubber compounds. The cure characteristic of palm kernel husk is comparable to that of carbon black. The work indicates that palm kernel husks can be exploited further by controlling particle size and particle size distribution, improving filler dispensation and also its surface functionality.

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