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Short Communication

Experimental approach to mechanical properties of natural rubber mixing with Calcium carbonate powder

Al-Mosawi A. I.[1]*, Ali M. M.[1] and Mohmmed J. H.[2]

[1]Department of Machines and Equipments, Technical Institute of Babylon, Babylon, Iraq.
[2]Department of Materials, University of Technology, Baghdad, Iraq.

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Mechanical properties of natural rubber (NR) and calcium carbonate as additive filler with amounts of 5, 10, 15, 20, and 25 parts per hundred (pphr) were studied. The influence of calcium carbonate content on hardness and tensile strength of NR were investigated. The results were obtained from the tests shown. NR hardness and tensile strength was enhanced after adding calcium carbonate powder and increasing these properties with increased percentage of powder as shown in the figures.

Key words: Natural rubber (NR), Calcium carbonate filler, mechanical properties.

INTRODUCTION

In its original state an elastomer is generally not very strong, does not maintain its shape after a large deformation, can be very sticky having even its consistency as chewing gum, has limited resistance to solvents and is prone to attack by oxygen, ozone etc. In a nutshell, useful articles cannot be made from it without modification. It is therefore necessary to blend an elastomer with certain additives to optimize its properties to meet a given service application or set of performance parameters (Niyogi, 2007). This process of blending various ingredients with elastomers, each having a specific function either in processing, vulcanization or end use of the product is known as 'compounding' and the formulation thus developed is a 'recipe' (Mihara, 2009).

Fillers is one of the major additives used in natural rubber compound and has marked effect and influence on rubber materials. The function of filler is to modify the physical and, to some extent, the chemical properties of vulcanizate. In rubber industry, fillers that are commonly in use are carbon black, china clay, and calcium carbonate (Egwaikhide et al., 2007). The mechanism of reinforcement of elastomers by fillers has been reviewed by several workers (Brennan and Jermyn, 1965). They considered that the effect of filler is to increase the number of chains, which share the load of a broken polymer chain. It is known that in the case of filled vulcanizates, the efficiency of reinforcement depends on a complex interaction of several filler related parameters. They 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 (Li et al., 2008).

*Corresponding author. E-mail: aliibrahim76@yahoo.com.

MATERIALS AND METHODS

Natural rubber (NSR 10) used in this study was obtained from Qilu Rubber Co. Ltd., Shan-dong Province, China, and calcium carbonate filler with (0.5 μ) particles were obtained from Auchi, in Edo State, Nigeria.

The batch was prepared from NR with addition of some of materials (such as zinc oxide, stearic acid, sulfur, antioxidant, Carbon black etc), calcium carbonate powder was added to rubber as a weight percentages at 5, 10, 15, 20, and 25 parts per hundred (pphr). Table 1 represents recipe for compounding the NR mixes.

Preparation of tests samples

Preparing samples of hardness test was done according to ASTM D1415 specification which is a disc shape with (40 mm) diameter and (4 mm) thickness. Samples of tensile test were prepared according to (ASTM D413) standards as a circular section with (6 mm) diameter and (115) length.

Measuring of mechanical properties

The international hardness test is used in the measurement of the penetration of rigid ball into the rubber specimen under specified

Table 1. Recipe for compounding the natural rubber mixes.

Ingredient	Parts per hundred (pphr)
Natural rubber	100
Filler	0-25
Zinc oxide	4
Stearic acid	2
Sulphur	1.5
Mecaptobenzothiazole	1.5
Processing oil	20

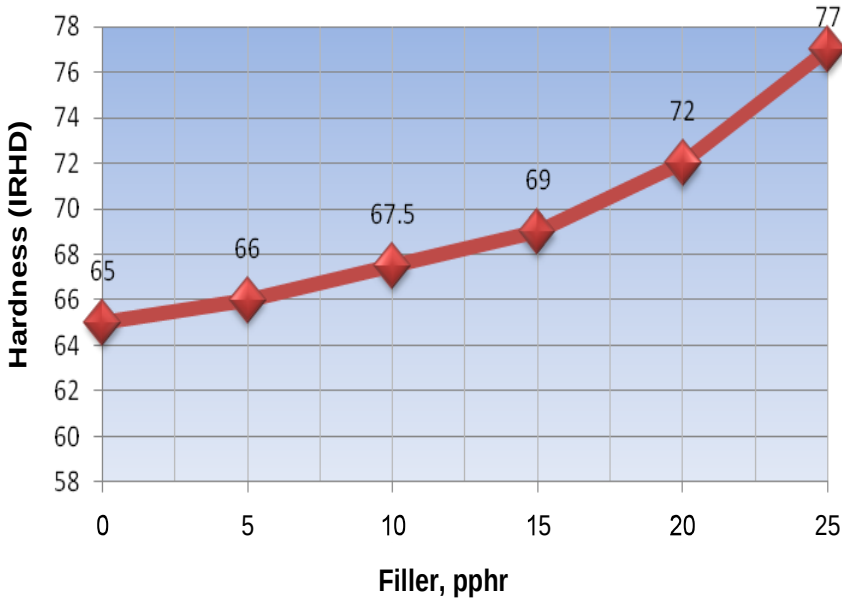

Figure 1. Hardness versus filler percentage for NR-calcium carbonate composition.

conditions. The measured penetration is converted to the International rubber hardness degrees (IRHD). The scale of degrees is so chosen that zero represents a material having elastic modulus equal to zero and 100 represents a material of infinite elastic modulus. Tensile strength test was carried out on Monsanto T10 tensometer in materials laboratory, Babylon University, Iraq.

RESULTS AND DISCUSSION

The effects of filler content on hardness property of NR were studied in this work and the results were presented in Figure 1. NR was reinforced with different filler percentage and the results show that there is increase in the hardness with increment in the calcium carbonate powder percent in the rubber and the increment is continue as a curve which may be attributed to the extra cross linking with the rubber, besides HMTA which results in increasing the surface tension of the recipe, that is, the recipe surface resists penetration which means increasing hardness. This result agrees with other results (Ahmad et al., 2004).

The tensile strength of NR- calcium carbonate was studied as a function of filler percentage and the results were presented in Figure 2. The results show that, tensile strength of blend increased when adding 5 pphr from calcium carbonate powder and this increment will continue to 25 pphr from calcium carbonate powder. This is due to the cross-linking of the calcium carbonate powder with rubber (Kim and Jeong, 2005).

Conclusion

The main aim of this work is to find out the effects of filler on the mechanical properties of NR. The preliminary results showed that, there is increase in hardness after adding calcium carbonate powder and this thing will continue with increased powder percentage. There is also increase in tensile strength after adding 5 pphr from calcium carbonate powder and this increment will

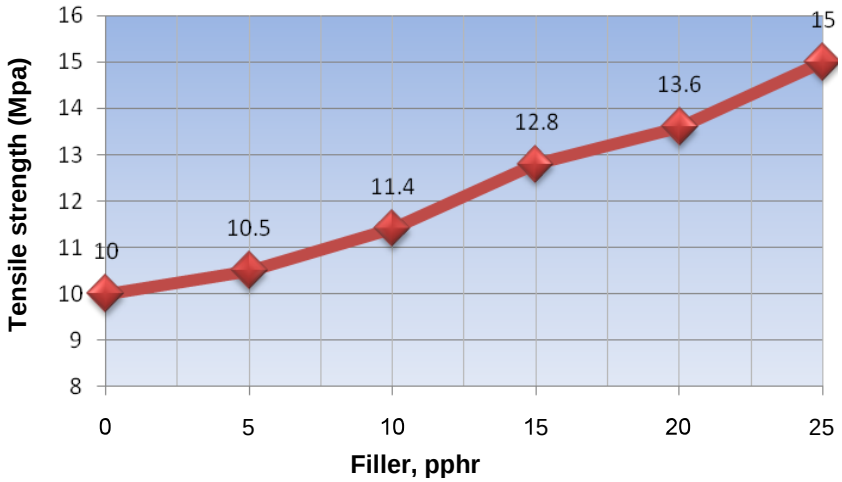

Figure 2. Tensile strength versus filler percentage for NR-calcium carbonate composition.

continue to 25 pphr.

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