



Effect of synthesized zinc stearate on the properties of natural rubber vulcanizates in the absence and presence of some fillers

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ABSTRACT

Zinc stearate was synthesized by precipitation method through two steps; neutralization of stearic acid by sodium hydroxide then double decomposition using zinc sulphate to precipitate zinc stearate. Mass balances of the two steps were calculated and the physical properties of the prepared zinc stearate were measured and compared to standard. It was characterized and incorporated it into natural rubber in the absence and presence of some filler through mixing process of rubber. The vulcanization process was carried out at 142 °C. The rheological properties of natural rubber mixes were measured using oscillating disc rheometer. The physico-mechanical properties of the vulcanizates were determined using tensile testing machine. It was found that, partial and complete replacement of synthesized zinc stearate instead of the conventional zinc oxide and stearic acid; enhanced the physico-mechanical properties of natural rubber. The measured reinforcing parameter value α_f can be arranged according to the type of filler as follows:

HAF > Hisil > CaCO₃ > Ca₃(PO₄)₂ > BaSO₄ > Talc

The highest value of α_f represents the strength of filler and consequently the reinforcing effect of carbon black (HAF) filler while the lowest value of α_f was observed for Talc which show moderate reinforcing effect of Talc. The scanning electron microscope study showed high surface homogeneity and good dispersion of zinc stearate through natural rubber chains in case of the vulcanizate containing 9 phr zinc stearate without filler. The investigated natural rubber vulcanizates tolerated thermal oxidative aging at 90 °C for 7 days.

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1. Introduction

The rubber industries contribute significantly to the nation's economy. Enhancements to quality, safety, security and properties of rubber architectures and products based on recommended developed technology and the elemental additives applied [1–3]. Condensed studies are carried out on rubbers and their ingredients to develop academic interest and to improve industrial applications [4–6]. Natural rubber is one of versatile materials of unique chemical and physico-mechanical properties assessed to various applications as tires, conveyor belts, hoses, etc.

Stearic acid and ZnO play an important role in the mechanism of vulcanization process of rubber. They act as activators for the accelerator and sulfur element to promote construction of sulfur crosslinking to the unsaturated part of long rubber chains under the vulcanization conditions as temperature, pressure, time, etc.

[7]. So, it was expected that zinc stearate may have an important effect on the vulcanization process.

Zinc stearate is a typical example of metallic soaps which are usually described as alkaline earth and heavy metal salts of fatty acids. They are insoluble in water and polar solvents such as alcohol and ether. Zinc stearate is the most powerful mold release agent and lubricant among all metal soaps that can be used in plastics and rubber industry [8,9].

Fillers are necessary as reinforcing materials for rubber in order to gain specific properties through two different ways; vanderval force and chemical bonds [10]. Research work was done using the following Einstein's equation to determine the volume fraction or shear modulus of filler [11].

$$G = G_o(1 + 2.5\phi + 14.1\phi^2) \quad (1)$$

where G and G_o are shear modulus of filled and unfilled rubber, ϕ is filler volume fraction.

Medalia [12] introduced the concept of rubber occlusion and replaced filler volume fraction with the effective filler volume

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