

## EFFECT OF RETARDERS ON CURE CHARACTERISTICS, KINETICS OF VULCANIZATION AND PHYSICAL PROPERTIES OF NATURAL RUBBER

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The effects of three retarders—benzoic acid, N-nitrosodiphenyl amine and N-(cyclohexylthio) phthalimide—on cure characteristics, kinetic parameters and physical properties of thiazole and sulphenamide accelerated natural rubber compounds were evaluated. The results indicated that the effect of the retarders depends on the type of accelerator used. The difference in the effect of the retarders on scorch and cure times of the compounds is explained based on kinetic parameters of the vulcanization reaction in the presence of the retarders. These observations agreed well with the already established reaction mechanisms of cure retardation.

**Key words:**— Natural rubber, Accelerators, Retarders, Scorch time, Cure time, Sulphur, Vulcanization kinetics.

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### INTRODUCTION

Vulcanization is the process by which chemical crosslinks are introduced between polymer chains, as a result of which the polymer attains higher strength and other elastomeric properties. For achieving high productivity, vulcanization time of the rubber compound should be as brief as possible and the use of ultra accelerators helps to attain shorter curing cycles. However, ultra accelerators adversely affect processing safety and storage life of the compounds. In the vulcanization of thick articles, the possibility of having uneven state of cure between the surface of the product and its core is very high because of very poor thermal conductivity of elastomers. Normally, in such cases, the surface will be overcured several fold while the core remains highly undercured. In order to make a balance between these

two states of cure and to ensure adequate processing safety, cure retarders are used in rubber compounds. Retarders prolong the induction period before the onset of vulcanization. An efficient retarder should influence the induction period, without affecting the actual curing time or the extent of vulcanization.

Different chemicals have been reported to function as cure retarders in rubber compounds (Trivette *et al.*, 1977). Carboxylic acids, anhydrides, nitroso compounds and N-substituted phthalimide derivatives have been widely used as cure retarders. Many of these retarders are highly effective in delaying the onset of vulcanization but have some undesired effects such as extending the vulcanization time, reducing crosslink density, discolouring the product or adversely affecting the activity of powerful antiozonants