

A FRESH INVESTIGATION ON ACTIVATOR EFFECTS IN ACCELERATED SULPHUR VULCANIZATION OF NATURAL RUBBER

In sulphur vulcanization of natural rubber (NR), the most commonly used activator system is the zinc oxide - stearic acid combination. Other metal oxide and fatty acid combinations received only less attention in this regard and their evaluation as practical activator systems is too incomplete and uncertain to merit regular use in industrial rubber compounding. Ghosh *et al.*, (1984) made a fresh relative evaluation of ZnO, PbO, PbO₂, MgO, CdO and Al₂O₃ separately in combination with myristic acid, palmitic acid, stearic acid and oleic acid as the activator systems for sulphur-vulcanization of NR employing N-cyclohexyl-2-benzothiazyl sulphenamide (CBS) as the accelerator. Considering different aspects including cost and availability, stearic acid found favour over other fatty acids. PbO and PbO₂ showed close, comparable or even improved effects over ZnO in some respects, more so in combination with small proportions of ZnO. The lead oxide activators, each in combination with ZnO in particular, deserved further studies for critical assessment and evaluation of their roles and effects. Results of related studies are presented in this paper.

The compound recipes are given in Table 1. The codes used are C and CF respectively for gum compounds and carbon black (SRF) filled compounds based on NR. In lone metal oxide activated compounds, subscripts 1, 2 and 3 are used after C or CF

to denote ZnO, PbO and PbO₂ respectively. For combination of ZnO/PbO and ZnO/PbO₂ in mixed metal oxide activated systems the corresponding subscripts in the compound code are 1, 2 and 1, 3 respectively. Further, subscript (a), (b) or (c) is used to the following weight proportions of ZnO and the other metal oxide (PbO or PbO₂) in the mixed oxide systems, viz., (a) 3.5;1.5, (b) 4.0;1.0 and (c) 4.5;0.5. The metal oxide (L. R. grade) was ground to 100 mesh, dried at 110°C under vacuum and cooled in a dry chamber before use.

Compounding was done following standard mixing sequence in an open mill for 30 min including mastication for 15 min at 70°C. Curing of each compound to a sheet of specified dimension was done at 150°C for 20 min. Curing parameters were studied rheometrically using a Monsanto Rheometer (Model 100). Cure rates were

Table 1. Recipe for NR based compounds, parts per hundred rubber

Ingredients	C	CF
Natural rubber (RMA 1X)	100.00	100.0
Metal oxide/s	5.00	5.00
Stearic acid	2.00	2.00
CBS*	0.65	0.65
Sulphur	2.75	2.75
SRF black	—	50.00
Process oil	—	5.00

* N-Cyclohexyl-2-benzothiazylsulphenamide