THE EFFECT OF INCORPORATION SEQUENCE OF CURATIVE INGREDIENTS ON CURE CHARACTERISTICS OF SOLID TIRE MIDDLE COMPOUNDS AND PROPERTIES OF RESULTANT VULCANIZATES

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Degree of Master of Science

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Thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Polymer Technology

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DECLARATION OF THE CANDIDATE & SUPERVISOR

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ABSTRACT

The purpose of this research is to study the effect of modification of incorporation sequence of accelerator and activators on cure characteristics, physical properties, mechanical properties and dynamic properties of solid tire middle compound.

Accelerator-activator masterbatch (MB) was prepared by mixing activators & accelerator in a rubber phase. A series of masterbatches were prepared using different concentrations and maturation periods of accelerator-activator combination and pre-vulcanization inhibitor. They were subsequently used in 1st stage compound mixing of a solid tire middle compound. Cure characteristics and selected properties of these masterbatches incorporated solid tire middle compounds were studied. Economics analysis of the best system among the candidate systems was also carried out.

It was found that the cure rate index improved by 52% with the accelerator-activator MB compared to the conventional method of curatives usage when 58.5 pphr accelerator-activator MB is used. No significant effect of the maturation time of MB on the cure characteristics and other properties was found. With the incorporation of activators and accelerators in the MB form, scorch time of the compound showed a slight drop which was overcome by the addition of 0.3 pphr pre-vulcanization inhibitors at the 2nd stage mixing stage.

Mechanical properties, dynamic properties, and visco-elastic properties of vulcanizates prepared using accelerator-activator MB and conventional methods were compared. Tensile strength, elongation at the break, blow-out time and storage modulus showed an improvement when MB incorporated vulcanizate with a slight reduction in 300% modulus, heat build-up, crosslink density, and loss modulus.

It was found that cure rate index improvement achieved associated with the reduction of curing cycle and energy consumption by around 10% and 12% respectively while maintaining other properties studied within the standard range of the conventionally prepared ones.

Key Words: Vulcanization, Accelerator, Activator, Masterbatch, Cure rate index, Optimum cure time, curing cycle time, Solid tire middle compound

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LIST OF ABBREVIATIONS

Abbreviation	Description
6PPD	N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine
AAMB	Accelerator Activator Masterbatch
ALK	Alkanolamide
ASTM	American Society for Testing & Materials
BR	Butadiene Rubber
CB	Carbon black
COM	Cost Of Manufacturing
CRI	Cure Rate Index
CTP	N-(cyclohexyl-thio)phthalimide
CV system	Conventional curing system
DBP	Dibutyl Phthalate
DMA	Dynamic Mechanical Analyzer
DTB	1-phenyl- 2,4-dithiobiuret
EAB	Elongation at Break
EPDM	Ethylene Propylene Diene Monomer
Et al	And Others
EV system	Efficient curing system
FEA	Finite Element Analysis
FF	Fast-extruding Furnace
GDP	Gross Domestic Product
GPF	General Purpose Furnace
MB	Master Batch

MDR	Moving Die Rheometer
M_H	Maximum Torque
M_L	Minimum Torque
NR	Natural Rubber
ODR	Oscillating Disk Rheometer
PPHR	Parts Per Hundrands of Rubber
PRL	Plastic Retention Index
PVC	Poly Vinyle Chloride
RPA	Rubber Processing Analyzer
RSS	Ribbed Smoke Sheet
SBR	Styrene Butadiene Rubber
SG	Specific Gravity
SRF	Semi Reinforcing Furnace
t_{90}	Optimum Cure Time
TBBS	N-Tert-Butyl-2-Benzothiazole Sulfenamides
TMQ	Polymerized 2,2,4-Trimethyl-1,2-dihydroquinoline
TMTD	Tetramethylthiuram Disulfide
TMTM	Tetramethylthiuram Monosulfide
t_{s2}	Scorch Time
TSR	Technically Specified Rubber
ZnO	Zinc Oxide

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