EFFECT OF OZONE ON NR / EPDM BLENDS

BY

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DECLARATION BY THE CANDIDATE

The work described in this thesis was carried out by me under the supervision of Mrs. Dilhara G. Edirisinghe (Rubber Research Institute of Sri Lanka, Ratmalana) and Mr. H.N.K.KChandralal (Rubber Research Institute of Sri Lanka, Ratmalana) and report on this has not been submitted in whole or part to any University or any other Institution for another Degree / Diploma. I also certify that this thesis does not include , without acknowledgement, any materials previously submitted for a degree in any universities, and to the best of my knowledge and belief it does not contain any materials previously published , written or oral communicated by another person.

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DECLARATION OF THE SUPERVISORS

We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the university for the purpose of evaluation.

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ABBREVIATIONS

a	- Flaw size
C	- Centigrade
CV	- Conventional vulcanization
d	- Thickness
DCPD	- Dicyclo pentadiene
DEG	- Di ethylene glycol
$\frac{dH}{dt}$	- Differential heat
DSC	- Differential scanning caloremetry
E	- Young's modulus
EB	- Elongation at Break
ENB	- Ethylene norbornene
EPDM	- Ethylene propylene diene ter polymer
EPM	- Ethylene propylene Monomer
EV	- Efficient vulcanization
F	- Maximum force
G	- Specific gravity
Gc	- Fracture energy
Gm	- Gibbs free energy of mixing
He	- Helium
Hm	- Enthalpy of mixing
IR	- Infra red
J	- Joules

Kg - Kilogram

LCB - Long chain branching

M - Mass

m - Meter

MBT - 2- Mercapto benzothiazole

MBTS - - Di benzothiazyl di sulfide

mg - Milli gram

mm - Milli meter

MPa - Mega pascal

Mw - Molecular weight

Ne - Neon

Ni - No of molecules of i^{th} component

nm - Nano meter

NR - Natural rubber

O_2 - Oxygen

O_3 - Ozone

Ơc - Tensile stress

OsO_4 - Osmium tetroxide

% - Percentage

p.p.h.r - Parts per hundred rubber

PE - Poly ethylene

PP - Poly propylene

ppb - Parts per billion

ppm	- Parts per million
R	- Universal gas constant
RSS	- Ribbed smoke sheet
SBR	- Styrene butadiene rubber
SEM	- Scanning electron microscopy
Sm	- Entropy of mixing
TEM	- Transmission electron microscopy
Tg	- Glass transition temperature
TiO_2	- Titanium di oxide
TMTM	- Tetra methyl thiuram mono sulphite
TQM	- 2,2,4, Trimethyl 1,2 dihydro quinolene
Ts	- Tear strength
TSR	- Technically specified rubber
UV	- Ultra violet
V	- Total volume
V_2	- Saybolt viscosity
VGC	- Viscosity gravity constant
Xi	- Mole Fraction of i^{th} component
χ	- Interaction parameter
δ	- Solubility parameter
ρ	- Density
$\varnothing$	- Volume fraction

ABSTRACT

Natural Rubber is considered to be a superior rubber compaired to synthetic counterparts, as far as physical properties of rubber compounds are concerned. But it fails like other unsaturated elastomers when it is subjected to the effect of ozone. The idea to protect the NR with antiozonants such as waxes and IPPD failed when exposed to 50 ppm ozone concentration. As the objective of the project was to formulate a rubber compound which possees both ozone resistance and physical properties, EPDM was blended with NR.

Introduction of EPDM rubber to replacing NR in the composition from 20% to 80% performed increasing ozone resistance. The blend of 60/40 NR / EPDM blend was found to be a reasonable blend which exhibits both good physical properties and ozone resistance.

The 60/40 NR/ EPDM blend made by milling EPDM with 6 pphr of petroleum jelly as the processing aid, before blending with NR gave good results in Tensile and Tear strenghs.

The degradation product formed by the attack on rubber by ozone was seen as frost on the surface of these compounds in the same extent. The IR analysis suggested this frost to be the Zwitterions, which is a decomposed product of ozonide with water.

The SEM and DSC results suggested that the morphology of these two blends is co-continuous. The blend of 60/40 NR/ EPDM and 40/60 NR / EPDM can be considered as a conversion point, where the effect of ozone becomes less significant at 150 hours ozone exposure. The SEM of 40/60 NR / EPDM suggest that the two blends in the co continuous state, the NR in this will be more masked by the EPDM for the ozone effect.

Observation in the SEM results indicated that the ozone attack on the rubber caused staining NR phase and eventually brightened the NR phase, thereby making it easier to distinguish the two phases in the blend by using SEM.