PHYSICO-MECHANICAL PROPERTIES OF NBR/EPDM RUBBER BLEND LOADED WITH DIFFERENT TYPES OF COMPATIBILIZERS

By

Reem Mohamed Salah Mahmoud

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Chemical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:

Physico-Mechanical properties of NBR/EPDM rubber blend loaded with different types of compatibilizers.

Key Words:
NBR; EPDM; Rubber blends; Compatibilizers; NBR/EPDM characterization.

Summary:

The purpose of the present research is to compare between the effect of different types of compatibilizers (Maleic anhydride, epoxidized soybean oil and styrene butyl acrylate S-BA copolymer), which was added to overcome the incompatibility between NBR/EPDM blend, on the rheological, mechanical, physical and thermal properties of NBR/EPDM blends as well as to obtain the optimum amount of each type of them which will give such a superior properties. Blends of EPDM and NBR were prepared with different ratio (100/0, 75/25, 50/50, 25/75 and 0/100 EPDM/NBR) and the effect of the blend ratio on the mechanical, rheological and thermal properties have been investigated. Then compatibilization of 50/50 blend, which gives the superior mechanical properties, was made by using (MA) with ratios (0.5, 1, 1.5 and 2 phr); EO (2.5, 5, 7.5 and 10 phr) and S-BA (2.5, 5, 7.5 and 10 phr) were used, and a study of their effect on all the previous properties were made as well. It was found that, among different rubber blends, the (50/50) NBR/EPDM blend gives the highest rheological, mechanical and thermal characteristics. Using of MAH; EO or S-BA as compatibilizing agents increase the rheological, mechanical and swelling properties and at the same time don't affect the thermal stability of the NBR/EPDM rubber blends. Finally, it is recommended, for the compatibilization of NBR/EPDM, to use 1phr MAH; 5 Phr EO or 5 phr S-BA as these amounts give the optimum rheological, mechanical and swelling properties for the NBR/EPDM rubber blends.

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List of Symbols and Abbreviations

AAGR : average annual growing rate

AAHR: aromatic hydrocarbon resins

ABS: acrylonitrile butadiene styrene

ACN: acrylonitrile

AMF: atomic force microscopy

ASTM: American society for testing and materials

AU: Polyester urethane

BCC: Business Communications Company

BR: butadiene rubber

BR: poly butadiene rubber

BR: Polybutadiene rubber

CBS: N-Cyclohexylbenzothiazole-2-sulfenamide

CMC: carboxy methyl cellulose

CR: Polychloroprene rubber

CSM : Chloro sulphonated polyethylene

CSM: Chlorosulphonated polyethylene

D: Diffusion Coefficient(Diffusivity)

DIPDIS : bis(diisopropyl)thiophosphoryl disulfide

DOTG: Di-o-tolylguanidine

DPG: Diphenylguanidine

DTG: derivative thermogravimetry

ECO: 65/35 Copolymers of epichlorohydrin and ethylene oxide

ENR : epoxidized natural rubber

EPDM: ethylene propylene diene monomer

EPR /EPM: ethylene propylene rubber

ESO: Epoxidized soybean oil

EVA/ EVM: ethylene vinyl acetate

EVASH :ethylene vinyl acetate copolymer functionalized with mercapto

HNBR: Hydrogenated Nitrile Butadiene Rubber (HNBR),

HSN: Highly Saturated Nitrile

IIR: butyl rubber

IIR: isobutylene-isoprene rubber

IR: isoprene rubber

M.p: melting point

MA /MAH: maleic anhydride

MA-g-systems: maleic anhydride grafted systems

MAH-g- EPDM: maleic anhydride grafted with ethylene propylene diene monomer

MBS: 2-Morpholinothiobenzothiazol

MBT: 2-Mercaptobenzothiazole

MBTS: 2,2Dithiobisbenzothiazol

M_H: Maximum torque

M_l: Minimum torque

MQ: Methyl-Polysiloxane Silicon rubber

NBR: Nitrile Butadiene Rubber

N-DCBS: Dicyclohexylbenzothiazole-2-sulfenamide

NR: natural rubber

NRC: non-reactive compatibilization/compatibilizer

NR-g-MMA: natural rubber-grafted-methyl methacrylate

PA: polyamide-6

PBT: polybutylene terephthalate

PC: Polycarbonate

PCL: Poly(epsilon.-caprolactone)

PET: Polyethylene terephthalate

Phr: part per hundred parts by weight

PMMA: Polymethyl methacrylate

PPE: poly(2,6-dimethyl-1,4-phenylene ether)

PS-b-PMMA: Poly Styrene-block-methyl methacrylate

PVC: poly vinyl chloride

RC: reactive compatibilization

S: Sulphur

S-B block copolymer: styrene butadiene block copolymer

SBAH: polystyrene-hydrolyzed poly(*t*-butyl acrylate) di block copolymer

SBR: styrene-butadiene copolymer

SEBS: styrene ethylene butylene styrene copolymer

SEM: scanning electron microscopy

Sp.grv.: specific gravity

Sulphur MC: magnesium carbonate coated grade of sulphur

TBBS: N-t-butylobenzothiazole-2-sulfenamide

T_{c90}: curing time

T_g: glass transition temperature (Tg)

TG: thermogravimetric analysis

T_i: Onset temperature

TMTD: Tetra methyl thiuram disulfide

TMTM: Tetra methyl thiuram mono sulfide

TOR: trans-poly octylene rubber

T_p: peak temperature