

High Performance Emulsified EPDM grafted with vinyl acetate as Compatibilizer for EPDM with Polar Rubber

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Abstract: Grafting of emulsified ethylene propylene diene (EPDM) with vinyl acetate monomer (VAM) (EPDM-g-PVAc) via emulsion technique was carried out to obtain an effective compatibilizer for blending (EPDM) with polar rubber (NBR). Different doses of (EPDM-g-PVAc) were incorporated in NBR/EPDM blends. The optimum dose for the compatibility process was investigated by the rheological characteristics using both Mooney viscometer and melt flow indexer. The results were confirmed by scanning electron microscope (SEM). The ultimate physico-mechanical properties of the vulcanizates (tensile strength, elongation at break, swelling in motor oil and thermal oxidative aging) gave evidence for the (EPDM-g-PVAc) as an effective compatibilizer. Good results have been achieved for the compatibility of these blends using 7.5phr of the (EPDM-g-PVAc). [Nature and Science 2010;8(10):348-357]. (ISSN: 1545-0740).

Key words: Emulsified EPDM, Emulsion, NBR/EPDM blends, EPDM-g-PVAc, Compatibilizer, and Mechanical properties.

Introduction

Nitrile rubbers^(1,2) have irregular chain structure and do not crystallize on stretching. Nitrile rubbers require a reinforcing pigment for high strength⁽³⁾. Oil resistance is the most important property of nitrile rubbers; this is the reason for their extensive use. The main uses of nitrile rubber are oil seals, tires, and tubes⁽⁴⁾

EPDM is the fastest growing elastomer among the synthetic rubbers since its introduction in 1963 it represents 7% of the world rubber consumption and it is the most widely used non-tire rubber. This is generally due to its excellent ozone resistance as compared to natural rubber and its synthetic counterparts (isoprene rubber (IR), styrene butadiene rubber (SBR), and butadiene rubber (BR)). In addition, EPDM can also be extended with fillers and plasticizers to an extremely high level and still give good processability and properties in its end products, which is a matter of price advantage. Moreover, it has an outstanding oxygen and ozone resistance, good electrical properties, little moisture adsorption, excellent resistance to weathering and chemicals, a good compression set, and a very good dynamic fatigue resistance⁽⁵⁻⁷⁾.

Mixing two or more polymers together to produce blends or alloys is a well established strategy for achieving a specified portfolio of physical properties without the need to synthesis specialized polymer systems. For example, acrylonitrile-butadiene rubber (NBR) compounds constitute

important class of elastomers due to its excellent oil resistance, abrasion resistance and mechanical properties. However, their ozone resistance is poor.

Blending⁽⁸⁾ ethylene-propylene diene monomer rubber (EPDM) and NBR is a good way to develop important class of materials with good elastomeric properties associated to improved tensile strength, ozone and oxygen resistance⁽⁹⁾.

It is most common for compatibilization to be achieved by addition of a third component (compatibilizer) or by inducing *in situ* chemical reaction between blend components (reactive blending)⁽¹⁰⁾ leading to modification of the polymer interfaces in two-phase blends, and thereby for tailoring of the phase structure and properties.

Block and graft copolymers whose segments are miscible with each polymer phase are normally employed for this purpose. However, such copolymers may be formed *in situ* by the addition of appropriate reactive or functional compounds during melt mixing under conditions of high temperature and shearing. This process is known as (reactive compatibilization). It is technologically more versatile and economical because of the facility of developing functional polymers as compared to the synthetic processes used for the preparation of graft and block copolymers with a desired macromolecular architecture. In addition, the efficiency of reactive compatibilization in improving interfacial adhesion is much better than common physical compatibilizers. Several functional polymers⁽¹¹⁾ have been developed

by grafting vinyl monomers such as vinyl silane, acrylic acid, or maleic anhydride on the main chain of commercial polymers⁽¹²⁾

The use of these functional polymers in blends containing polymers with other functional groups (e.g., hydroxyl, carboxyl, or amine groups) gives rise to polymer materials with improved mechanical performance, more uniform morphology, and higher interfacial adhesion because of the effective anchorage between the phases, which is achieved by the *in situ* formation of the graft or block copolymer.

The mechanical properties of a blend are parameter of the phase morphology and the interphase adhesion. Both of which are important from the point of view of stress transfer within the blend in its end-use application.

The compatibilization processes can interact in complex ways to influence final blend properties. The first one is to reduce the interfacial tension in the melt, causing an emulsifying effect and leading to an extremely fine dispersion of one phase in another. The second effect is to increase the adhesion at phase boundaries giving improved stress transfer. The third one is to stabilize the dispersed phase against growth during annealing, again by modifying the phase-boundary interface.

There are different lines to improve miscibility of polymers.

(a)-Achievement of thermodynamic miscibility. (b)-Addition of block and graft copolymers. (c)-Addition of functional/reactive polymers. (d) *-In situ* grafting polymerization (reactive blending)⁽¹³⁾.

The physical blending of two polymers gives a new product with both physical and mechanical properties are usually different from those of the individual components. The degree of compatibility of the two components plays an essential role in the applicability of the final product in many industrial fields. Many experimental techniques are widely used for determining the degree of compatibility.

These are electron microscopy, differential scanning calorimetry, differential thermal analysis, dielectric permittivity, viscometric analysis, inverse gas chromatography techniques and mechanical analysis. Two extremely accurate techniques are also used for investigation of the degree of compatibility, namely dynamic mechanical thermal analysis and ultrasonic velocity⁽¹⁴⁾

The aim of the present work is to investigate the use of modified emulsified (EPDM) rubber by grafting with vinyl monomer (EPDM-g-PVAc) as compatibilizer for (EPDM/NBR) rubber blend. The grafted (EPDM) with vinyl acetate monomer will incorporated in different doses with variable

concentration of (EPDM/NBR) blend ratio. The influence of the compatibilizer is studied by the help of the rheological properties using both rheometer, Mooney viscometer and melt flow indexer. Also, scanning electron microscope (SEM), physico-mechanical properties, swelling in motor oil and thermal oxidative aging will be studied.

Experimental

Materials

- Sodium dodecyl benzene sulfonate (SDBS): (Aldrich) Specific Gravity 1.02.
- Cetyl alcohol (1-hexadecanol) (CA): (Aldrich) density 0.819 g/cm³.
- EPDM used for grafting: Buna EP 8950: (Bayer) Ethylene propylene diene monomer rubber (EPDM), Mooney viscosity, (ML 1+4) 125 °C, ethylene content 50%.
- Toluene: (Aldrich) analytical grade.
- Neonyl-phenol exoylated (NP30): white solid, cloud point 73 hydroxyl value 36-45 pH 6-7, HLB 17.3 (Disponal NP30) Cognis group
- Poly vinyl alcohol (PVA): hydrolysis 87-89, viscosity (cps) 45-55, pH 4.5
- Potassium per sulfate fine chemical from Sigma Aldrich
- Deionized water: was used for all lattices.

- EPDM used for rubber formulations: Ethylene propylene diene monomer rubber (EPDM) Dutral Ter 447 Vistalon 6505, propylene content, (41-44)% Mooney viscosity ML (1+4) 125 °C (60-66), density, gm/cm³(0.86+0.01), Produced by Polimeri Europa, Italy.
- Butadiene acrylonitrile rubber (NBR): Krynac 33/45, with 33% acrylonitrile content and 45 Mooney viscosity (ML 14/100 °C), from BAYER Chemical Company, Germany.
- Other compounding rubber ingredients were of commercial grades used in industry.

Techniques

Emulsification of EPDM⁽¹⁵⁾

Emulsified (EPDM) can be prepared as follows: At first step (EPDM) was dissolved in toluene in order to reduce its viscosity (organic phase). Sodium dodecyl benzene sulfonate (SDBS) and Cetyl alcohol (CA) were separately dissolved in water (aqueous phase). The second step, the organic phase was added to the aqueous phase slowly drop wise, applying high shear using (Hedolph mixer) for 5 minutes.

The size of the eventually swollen polymer particles was reduced by processing the emulsion product with the high speed homogenizer (Greaves

mixers Model A 7 liters 40 watt). Finally toluene was removed by distillation at temperature about 50 °C under reduced pressure.

Grafted emulsion polymerization

The polymer lattices based on vinyl acetate were prepared by semi batch emulsion polymerization technique with solid content of 50%. Distilled water, residual emulsifiers, NaHCO₃, part of initiator NP30 and polyvinyl alcohol were added into the four-neck flask equipped with continuous stirring under reflux. The polymerization reaction was carried out by adding 10% of vinyl acetate monomer drop wise to the mixture at 80 °C using thermo stated water bath for 30 min under an inert atmosphere of N₂.

The recipe used for preparation of polymer lattices is given in Table (I). When the reaction mixtures appeared blue and no evident back flow existed in the reactor, the remaining amount of the vinyl acetate monomer and the emulsified EPDM rubber as well as calculated amount of initiator were step wise added into the reactor within 3hours.

The prepared emulsion was precipitated by adding excess amount of methyl alcohol, the precipitate dried, grinded and used as compatibilizer.

Mixing⁽¹⁶⁾:

All rubber mixes were prepared on a laboratory two-roll mill of 170 mm diameter and 300 mm working distance. The speed of slow roller was 24 rpm with 1:1.4 gear ratios. The compounded rubber was left over night before vulcanization.

Vulcanization⁽¹⁷⁾

Vulcanization was carried out on a heated platinum press under pressure of about 40 kg/cm² and temperature of 152 ± 1 °C.

Physical testing:

Rheometric characteristics⁽¹⁸⁾:

Minimum torque (M_L), maximum torque (M_H), curing time: Time at 90% cure (t_{c90}), scorch time (t_{s2}) and cure rate index (CRI) were determined, using a Monsanto Oscillating Disc Rheometer model-100.

Physico-mechanical properties⁽¹⁹⁾:

Tensile strength, elongation at break, modulus at 100% strain were measured at room temperature using the tensile testing machine (Zwick 1425) with crosshead speed 50 rpm, according to (ASTM D 412 – 1998).

Swelling⁽²⁰⁾:

Swelling was determined according to (ASTM D 471 – 1998). The samples were immersed in in motor oil at 100 °C for seven days.

The swelling value (S.V.) was calculated as follows:

$$S. V. = [(W_i - W_o) / W_o] \times 100$$

where:

W_o = weight before swelling

W_i = weight at time t_i

Thermal oxidative aging⁽²¹⁾:

Accelerated aging was carried out in a good aerated electric oven at 90 ± 1 °C for different time periods.

Rheology measurement.

Mooney viscosity⁽²²⁾

A Mooney viscometer (Monsanto model 1500; St. Louis, MO) with a large rotor at a test temperature of 100°C was used to determine the Mooney viscosity (ML1+4 at 100°C), according to (ASTM D1646-1987) and reported in Mooney units.

At least five samples were used for each measurement. The obtained values of the different blend ratios, in absence and presence of (EPDM-g-PVAc) were drawn against the different blend ratios.

Melt flow index

The melt flow index was determined by using a melt flow indexer of type Zwick 401, where the readings in gm/10 min., were drawn against the different blend ratios in presence and absence of (EPDM-g-PVAc).

Scanning electron microscopy

Samples were cutter from rubber blend. The rubber specimen size was 10 mm diameter and it was circular in shape. These samples were subjected to sputter coating (Edwards's model S 140A) of gold ions to have a conducting medium. Sputter coated samples were scanned with (JEOL Model JSM-T20) (SEM) microscope at magnification X500.

Results and discussion

The grafting of hydrophobic vinyl monomers onto emulsified (EPDM) was carried out by emulsion polymerization using free radical initiation. The emulsion recipe was represented in Table (1). Many trials were carried out to study the effects of the initiator concentration, surfactant type as well as concentration, monomer concentration and the reaction temperature on the conversion, the grafting efficiency the water absorption of the grafted (EPDM-g-PVAc) films, and the colloidal stability of the grafted emulsion latexes at low pH. Infrared

spectroscopic analysis and TEM confirmed that PVAc was grafted onto the emulsified EPDM rubber particles.

Table (1): Recipe of the grafted EPDM

Ingredient	Amount (gm)
Vinyl acetate monomer	50
Emulsified EPDM	100
Potassium per sulphate	0.2
Poly vinyl alcohol	2.5
Neonyl-phenol ethoxylated NP30	0.4
Distilled water	50
Sodium Acetate	0.3

Table (2) represents the obtained data of grafted (EPDM-g-PVAc) emulsion and tested film.

Table (2): Characteristics of the prepared two copolymer emulsions

Properties	Value
pH ⁽²³⁾	5.5
Solids by weight, (%) ⁽²⁴⁾	45
Conversion, (%) ⁽²³⁾	97
Wet coagulum 100 mesh, (g/l) ⁽²²⁾	4.3
Particle size, (nm) (TEM)	110
Water Absorption (%)	10
Grafting efficiency (%) ⁽²⁵⁾	40

The following infra red figures (1a, 1b, and 1c) show that (PVAc) was grafted onto the emulsified EPDM rubber particles. The spectra of figure (1a) showed the absorption peaks of typical (EPDM) at 2855–2955 cm^{-1} (CH_2 and CH_3 stretched), 1375, 1460 cm^{-1} (CH_2 and CH_3 bending), respectively.

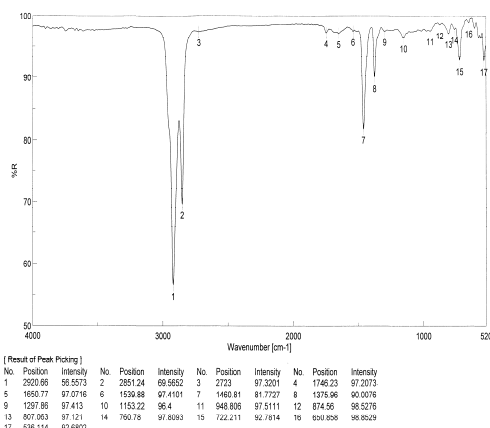


Fig (1a) : FTIR of EPDM rubber

Figure (1b) represent two sharp beaks at 1729 cm^{-1} and 1226 cm^{-1} for carbonyl group of the ester, while the sharp beak at 1369 cm^{-1} and weak band at 2924 cm^{-1} for alkanes group of the ester.

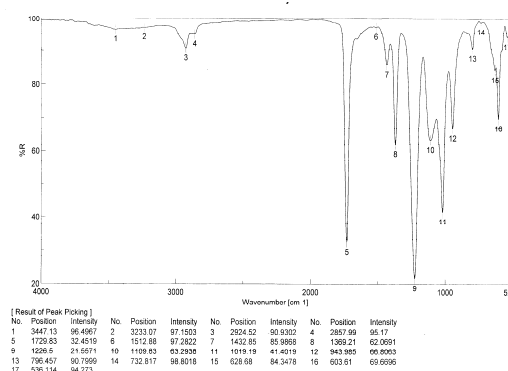


Fig. (1b): FTIR of Prepared vinyl acetate homo polymer

As shown from figure (1c), the spectra confirms the grafting of (PVAc onto EPDM), where the intensity of the absorption peaks at positions 2963 cm^{-1} , 1090 cm^{-1} and 1080 cm^{-1} increased while the absorption peak at 800 cm^{-1} appeared after grafting. This peaks is due to the increasing of the alkanes groups in the prepared polymer.

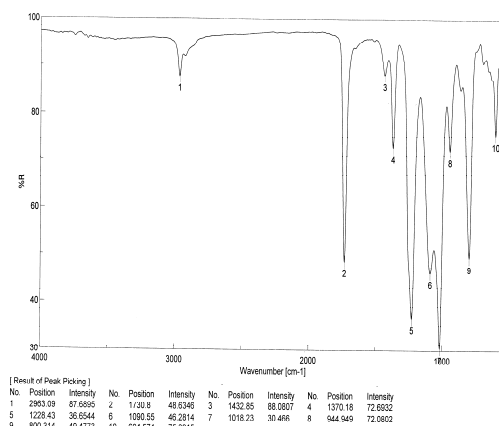


Fig (1c): prepared Poly vinyl acetate grafted on EPDM

The morphology of the particles was examined using cryo-transmission electron microscopy (cryo-TEM). For the present work, the use of (cryo-TEM) was required because of the low glass transition temperature of the (EPDM) phase. To perform (cryo-TEM) analysis, each latex sample was applied onto a microscopy grid. The thin aqueous film obtained was then vitrified in liquid ethane before being transferred to a Philips CM12 microscope, for examination at liquid nitrogen temperature. Dehydration and major reorganization

of the latex particles were prevented by the low temperature.

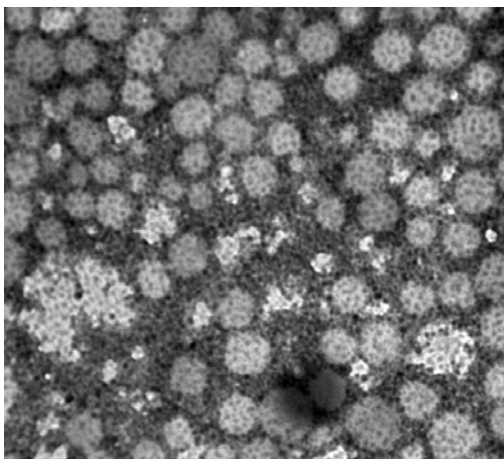


Fig. (2): TEM of the prepared grafted polymer (EPDM-g-PVAc)

It is clear from figure. (2), that the all particles size is nearly homo dispersed and the particles had non spherical shape this is due to the grafting effect of the (PVAc) onto (EPDM).

Effect of the prepared compatibilizer on the rheological properties of (EPDM/NBR) blends^(26, 27,28)

The physical properties of rubber blends are responsible for the quality of rubber goods for domestic life. Therefore, it is necessary to study the effect of the rheological properties of the uncured investigated rubber blends using oscillating disk rheometer, Mooney viscosity as well as melt flow indexer.

Table (3) summarizes the rheometric characteristics of (NBR/EPDM) blends without and with different phr of the prepared compatibilizer (EPDM-g-PVAc).

Table (3): Rheometric characteristics of (EPDM/NBR) blends without and with prepared compatibilizer at 162 °C

Properties	EPDM 100	EPDM/NBR 75/25	EPDM/NBR 50/50	EPDM/NBR 25/75	NBR 100
Without compatibilizers					
M_L (dN.m)	0.8	1	1.2	1.5	1.6
M_H (dN.m)	5	5.3	5.4	5.7	5.6
tc90(min.)	18.1	20.35	19.28	19.71	23.14
ts2 (min.)	2	2.2	2.4	2.6	3.1
CRI(min-1)	6.8	6.8	6.7	7.4	8.4
5 phr EPDM-g-PVAc					
M_L (dN.m)	0.7	0.9	1	1.2	1.5
M_H (dN.m)	4.5	4.7	4.9	4	3.7
tc90(min.)	16	17.6	16	17.7	19.7
ts2 (min.)	1.9	2	2.1	2.2	2.5
CRI(min-1)	7.9	8.4	9.2	8.5	9.4
7.5 phr EPDM-g-PVAc					
M_L (dN.m)	0.8	0.9	1.2	1.3	1.3
M_H (dN.m)	4.6	4.7	4.8	3.6	3.1
tc90(min.)	14	13.9	12.5	13.9	16
ts2 (min.)	1.64	1.66	1.62	1.79	1.95
CRI(min-1)	8.3	9.8	10.9	10.17	10.2
10 phr EPDM-g-PVAc					
M_L (dN.m)	0.8	0.8	1.1	1.2	1.2
M_H (dN.m)	4.5	4.5	4.4	3.5	2.8
tc90(min.)	13.5	13.5	13.5	13	14
ts2 (min.)	1.77	1.86	1.97	2.2	3.9
CRI(min-1)	6.8	7.5	8.33	7.8	8.46

ZnO 5; Stearic acid 2; CBS 1; Sulpher 2.5; Di butyl Phthalte 5; Carbon Black 40

Where

Minimum torque: (ML);

Maximum torque: (MH);

Optimum cure time at 90(%): (tc90);

Scorch time: (ts2)

Cure Rate index: (CRI)

The obtained data show that, in absence of compatibilizer as well as the increase of NBR content in the blend resulted an increase in maximum (M_H) and minimum (M_L) torque formula.

Moreover, (M_L) value, which reflects minimum viscosity of the mixes, was slightly decreased by the presence of the prepared compatibilizer; while, the maximum torque (M_H) was decreased by increasing the phr of prepared compatibilizer. In addition, the optimum cure time t_{C90} decreased generally by the addition of prepared compatibilizer.

From the previous results, there are dramatic changes of the cure rate index, the cure rate increased as the phr of the prepared compatibilizer increased especially at 7.5 phr with 50/50 (EPDM/NBR) blends.

It is clear from Table (3) that the blend ratio 50/50 (EPDM/NBR) had the best results in all properties of the blend without and with the compatibilizer

There are many different techniques for investigation of rubber blend compatibility, among these techniques, the rheological methods, the scanning electron microscopy (SEM), the differential scanning calorimetry and the dielectric permeability measurements. The rheological techniques used here are measuring the Mooney viscosity and the melt flow index.

Figure (3) illustrates Mooney viscosities of the different ratios of (EPDM/NBR) rubber blends in presence of different phr of (EPDM-g-PVAc) 0, 5, 7.5 and 10 phr). It is obvious that the results of the blend ratios of (EPDM/NBR) in presence of 0, 5 and 10 phr give curved lines, which reflects that these ratios are inadequate to achieve a compatible blend. On the other hand, the obtained results in case of using 7.5 phr of (EPDM-g-PVAc), gave a straight line relationship.

This means that the latter ratio is efficient to achieve compatibility for the rubber blend under investigation.

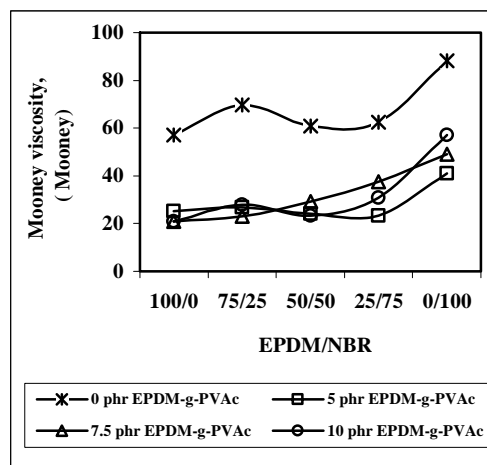


Figure (3): EPDM/NBR blend ratios with different phr of EPDM-g-PVAc, versus the Mooney viscosity

Furthermore, measuring the melt flow index to estimate the compatibility of the rubber blend, as an additional confirmation for the validity of this aforementioned ratio to be used as compatibilizer.

Figure (4) illustrates the melt flow index (gm/10min) of the different blend ratios of (EPDM/NBR) in presence of different phr of (EPDM-g-PVAc). It was found that the ratio of 7.5 phr of the compatibilizer gives a straight line relationship, which gives further evidence for the suitability of using 7.5 phr (EPDM-g-PVAc) as a compatibilizer for (EPDM/NBR) blend.

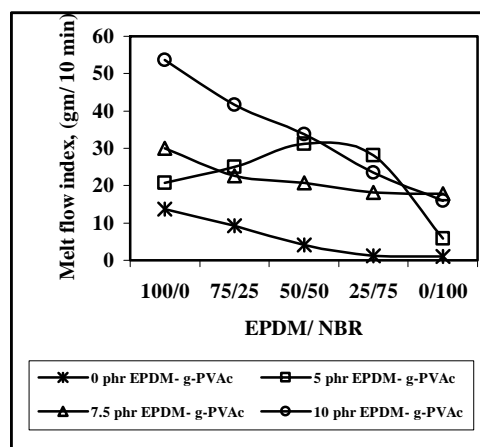
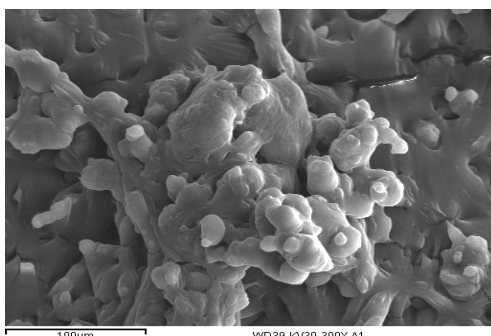


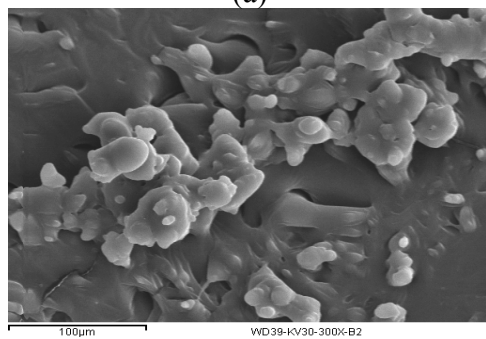
Figure (4): Melt flow index (gm/10 min) of the different blend ratios of (EPDM/NBR) blend with different phr of (EPDM-g-PVAc) compatibilizer

Effect of the prepared compatibilizer on the morphological properties of EPDM/NBR blends

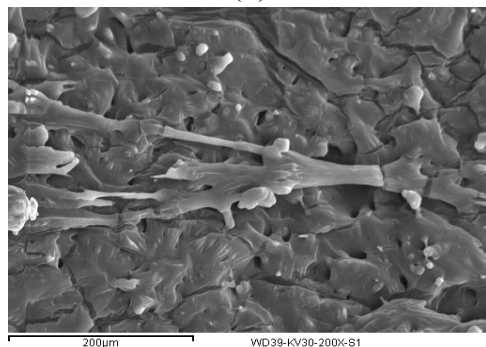
Morphology is a major factor which can determine how much extent the blends are compatible. The main factor that determines the final morphology of the mixes is determined by their composition. Figure (5a) displays (SEM) micrograph showing the morphology of 50/50 (EPDM/NBR) blend without any compatibilizer. The inspection of this micrograph indicates two phases with irregular shape. This means that (EPDM/NBR) blends are completely immiscible, where large (EPDM) domains coagulated on the (NBR) matrix.



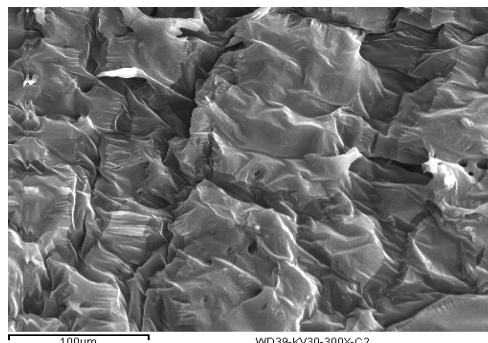
(a)



(b)



(c)



(d)

Figure (5): SEM of 50/50 (EPDM/NBR) rubber blend with different phr of (EPDM-g-PVAc) (a) 0 phr, (b) 5 phr, (c) 7.5 phr and (d) 10 phr

The compatibility of (EPDM/NBR) system is improved by the addition of a (EPDM-g-PVAc) compatibilizer in different phr (5, 7.5 and 10 phr) as seen from figure (5b, 5c and 5d). Also, the modification resulted in noticeable surface hardening and physical changes in the surface are expected to influence both the deformation and adhesion of the two rubbers. On the other hand, compatibilizers improved both morphology and the compatibility of the blend due to the reduction of the interfacial tension between (EPDM) and (NBR) rubbers. It was seen that the size of the dispersed phase (EPDM) domains decreases with the addition of compatibilizer and no gross phase separation is observed in the blend as shown in figure (5b-5d).

Effect of the prepared compatibilizer on the mechanical properties of (EPDM/NBR) blends

The mechanical properties is a good tool to evaluate the most efficient proportion of the compatibilizer under investigation (EPDM-g-PVAc) of the two parent rubbers (EPDM & NBR) and 50/50 blend ratio were compounded as listed in Table (3) and cured according to their optimum cure times.

Figures (6, 7) show the mechanical properties (tensile strength and elongation at break) determined and plotted against the different phr of the compatibilizer.

The theoretical average values of both the two parent rubbers were calculated and plotted in the figures. From figure (6) it is obvious that the tensile strength of 50/50 (EPDM/NBR) blend ratio with 7.5 phr of the compatibilizer under investigation is greater than the obtained average value. This means that this ratio of the compatibilizer shows a synergism.

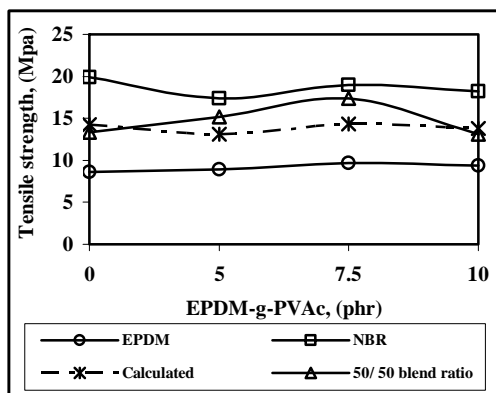


Figure (6): Tensile strength, (MPa), versus (EPDM-g-PVAc) phr, of the vulcanizates of both the parent rubbers and 50/50 (EPDM/NBR) blend ratio

From the data obtained from figure (7), it can be noticed that the value of elongation at break for 50/50 (EPDM/NBR) blend ratio with 7.5 phr compatibilizer is very close to the value of the calculated average value. This may be due to the synergistic effect of the compatibilizer and the (EPDM/NBR) blend.

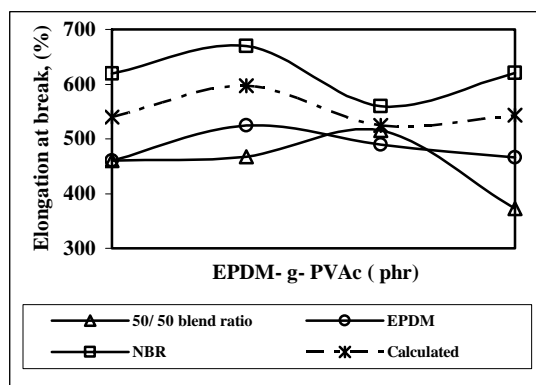


Figure (7): Elongation at break, (%), versus (EPDM-g-PVAc) phr, of the vulcanizates of both the parent rubbers and 50/50 (EPDM/NBR) rubber blends

Effect of the prepared compatibilizer on the thermal oxidative aging properties of (EPDM/NBR) blends

The main objective of this work is concentrated in tailoring of a rubber blend that has the advantage of thermal stability beside motor oil swelling resistance. So, the 50/50 (EPDM/NBR) blends were compounded as listed in Table (3) and cured according to their optimum cure times without adding effective antioxidant. The tensile strength, and the elongation at break were determined for the

cured samples before and after thermal aging at 90 °C for different periods of time.

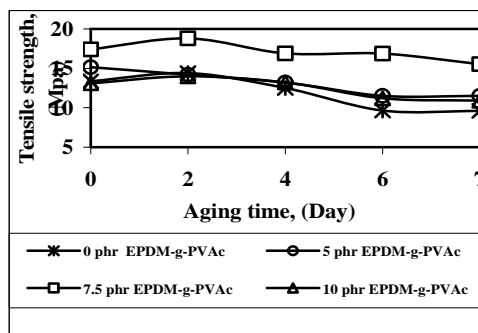


Figure (8): Tensile strength, (MPa), versus thermal aging time, day, at 90 °C of the vulcanizates of 50/50 (EPDM/NBR) blend ratio of with different phr (EPDM-g-PVAc)

The obtained results were plotted in figures (8, 9). It is clear from these figures that the 50/50 (EPDM/NBR) blend ratio with 7.5 phr of (EPDM-g-PVAc) shows the most thermal stable behaviour, in spite of the absence of any antioxidant. This means that the synergistic effect of the prepared compatibilizer (EPDM-g-PVAc) at 7.5 phr for 50/50 (EPDM/NBR) blend ratio is more effective than the other doses.

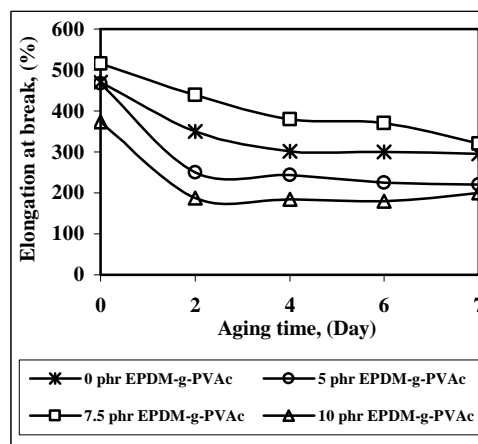


Figure (9): Elongation at break, %, of 50/50 (EPDM/NBR) blend with different phr of (EPDM-g-PVAc) versus thermal aging time, day, at 90 °C

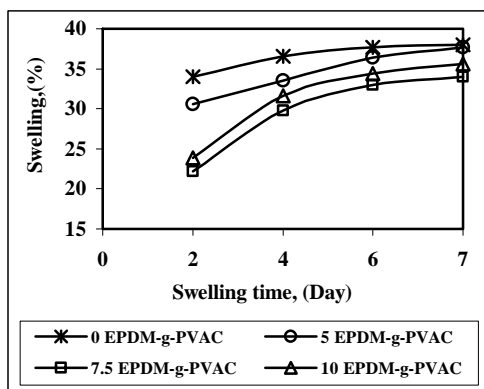


Figure (10): Swelling in motor oil of the vulcanizates 50/50 (EPDM/NBR), (%), versus swelling time, (day) with different phr of (EPDM-g-PVAc), at 100 °C

The oil resistance is an important property for rubber articles, which may be exposed to oil during usage. Therefore, to study the oil resistance of the 50/50 (EPDM/NBR), in absence and presence of prepared compatibilizer, the prepared vulcanizates were immersed in motor oil at 100 ± 1 °C for different time periods up to 7 days. The obtained results are shown in figure (10). It is clear from the figure that the swelling of the blend vulcanizates, in motor oil, decreased as the prepared compatibilizer increased.

It is obvious that the swelling in motor oil gives the lowest values upon using 7.5 phr of (EPDM-g-PVAc) as compatibilizer

Conclusions:

From The previous results, it can be concluded that:

1-The incorporation of compatibilizers such as (EPDM-g-PVAc) into (EPDM/NBR) blend greatly enhanced their compatibility, improved the rheological as well as physical properties of rubber blends.

2-The addition of NBR to EPDM improved the motor oil swelling resistance of EPDM. Blending of the two individual rubbers without a compatibilizer generally exhibits non-synergistic effect with respect to the physical properties.

3-The prepared compatibilizer (EPDM-g-PVAc) improved the thermal oxidative properties of the blend especially 50/50 (EPDM/NBR) blend ratio in both mechanical and swelling in motor oil investigations.

4-The best dose of the prepared compatibilizer (EPDM-g-PVAc) was 7.5 phr.

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