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Mechanical Behavior of NBR-PVC Mixture After Immersion in Different Media

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Abstract
Polymer blends are capable of providing materials with extended useful properties beyond the range that can be obtained from single polymer equivalents. Effect of immersion in oil and water on hardness of Acrylonitrile butadiene rubber (NBR) Blends reinforced by (30,50, and 70%) PVC were studied in this paper. The results from this work show that the strength will impairment after immersion in oil and water as a result of the penetration of the oil and water molecules within NBR-PVC blend, which increase the extending between the main chains and cause the weakening in secondary forces of (vander walls) and crosslink so that the Brownian motion of molecular chains will increases Which leads to a decrease in hardness.

1. Introduction

Polymer blends are physical mixtures of two or more structurally different homopolymer or copolymers and they interact through secondary forces with no covalent bonding [1] (see Fig.1). Polymer blends are prepared by various methods and among them solution blending is very simple and rapid because it requires simple equipment such as glass plates only and not involved any complicated process.

Blending of three or more polymers has become an increasingly important technique for preparing materials with tailormade properties different from those of the constituent polymers [2]. Blending of polymers may result in reducing their basic cost, improving their processing and maximizing their important properties [3].

Many articles were devoted to studying the effect of different reasons on the compatibility, miscibility, morphology, and mechanical properties for the polymer blend [4]. Willis and Favis studied the processing and phase morphology relationship of compatibilized polylefin-polyamide blends with the help of an ionomer compatibilizer [5]. They found that there is an abrupt increase in dispersion and interfacial adhesion and a decrease in particle of the dispersed nylon phase. This was reported to be due to specific interaction between nylon and the ionomer at the interface in the blend of polyethylene and nylon similarly [6].

Wycisk R, et. al prepared polymer blend from polyethylene and polystyrene, there are three samples of different molecular weight from polystyrene. They found the morphology of the blends changed where spherical domains of one component, dispersed in continuous matrix of the other, changed to a highly non homogeneous mixture of fibrous or cabbage-like macro-domains of both components. This change in morphology depends on the composition and molecular weight of polystyrene [7].

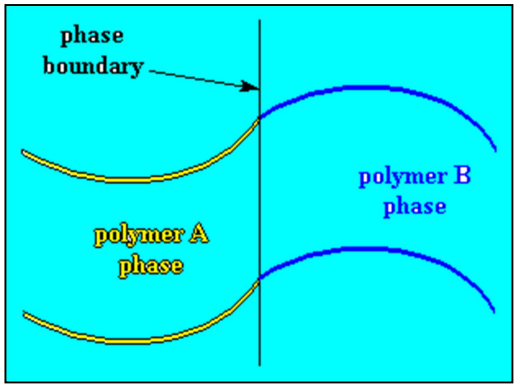

Fig 1. *Polymer blend.*

Commonly abbreviated PVC, is the third-most widely produced plastic, after polyethylene and polypropylene. PVC is used in construction because it is more effective than traditional materials such as copper, iron or wood in pipe and profile applications[8]. It can be made softer and more flexible by the addition of plasticizers, the most widely used being phthalates. In this form, it is also used in clothing and upholstery, electrical cable insulation, inflatable products and many applications in which it replaces rubber [9].

Acrylonitrile butadiene rubber (NBR) NBR, also termed nitrile rubber, is an emulsion copolymer of acrylonitrile and butadiene. Acrylonitrile content varies from 18 to 50%. Unlike CR, polarity in NBR is introduced by copolymerization with the polar monomer, acrylonitrile, which imparts excellent fuel and oil resistance [10].

2. Experiment Part

The development of a new rubber composite material for applications in shock absorbers or automobile supporters requires many mechanical tests which simulate conditions that these parts are subjected to such as fatigue, impact, compression….etc .Also other tests are necessary under the effect of temperature, and oils.

The suitable recipe for these applications suggests processes to improve these parts and to provides laboratory samples of various recipes for testing the various kinds of recipes for study under the effect of addition of the suggested materials required a preparation of some reinforcement materials.

1. Raw Material: Acrylonitrile butadiene rubber (NBR),
2. Reinforcement Material: Polyvinyl chloride (PVC).

The Batch No.1: The batch was prepared from Acrylonitrile butadiene rubber (NBR) with addition of some of materials (such as zinc oxide, stearic acid, sulfur, Antioxidant, Carbon black.etc).

The Batch No.2: For development of new kinds of rubber composite recipes which are suitable for application as shock absorbers or automobile supports and comparing them with the original sample, some modifications on batch were (No.1) carried out and the resultant batch is called batch (No.2), where Polyvinyl chloride PVC with as a weight percentages (30, 50 and 70)%wt. was added .

The batch is prepared by adding the materials accord to their order in Table 1 by using the laboratory mill as shown in Fig. 2 and in stepwise with different mixing time according to Table 2.

Table 1. *The materials content in the master batch.*

Materials	The content pphr %
PVC	0, 30, 50, 70
NBR	100, 70, 50, 30
Carbon black 660	40
MBTS	0.7
Sulfur	1.5
Zinc oxide	3
Stearic acid	1

Table 2. *The step for making recipe master batch.*

Item	description *	Time min
1	pass NBR between the two rolls mill several times with decreasing the distance between the two rolls to the extent of (0.5-1) mm at 70 c	5
2	Add sulfur follows by mixing for homogenization of the materials under room temperature	5
3	Add of zinc oxide and repeat item2	5
4	Add of stearic acid and repeat item2	5
5	Add DOP oil. The addition takes place by (1-5)ml per minute with repeating item2	8
6	Add accelerator TMTD and repeat item2	5
7	Add antioxidant and repeat item2	5
8	Add of HMT (after add novolac) and repeat item2	5
9	The mixing process continues for more time in order to get a good homogenization and paste draw as plate with a thickness about 7-10 µm	

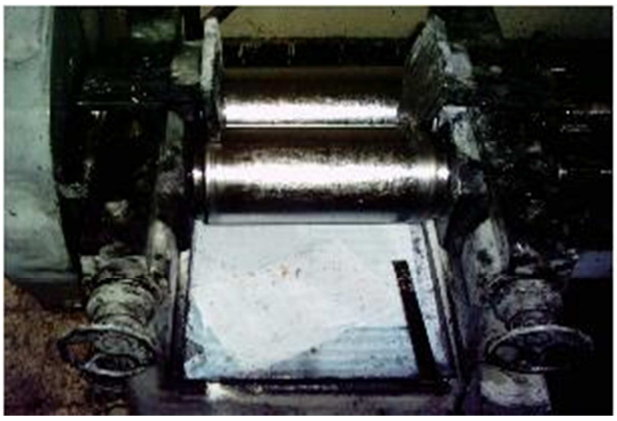

Fig 2. *Laboratory mill.*

Immersion: PVC/NBR blend specimens were immersed in 80 ml engine oil and distilled water at room temperature then observed the changing Hardness of blend.

Mould for Testing hardness: For preparing samples for hardness tests, the mould in the laboratories of Tires Company was used The mould consists of three parts, the middle part in a dimension of (200×180×6.5mm) which contains four circular equivolume open with 6.5mm diameter and 35 mm thickness while one of other two the parts on of is bottom base and the other is a cover for the purpose of

samples thickness regulation. They have a dimension of (150×150×10mm) as shown in Fig. 3.

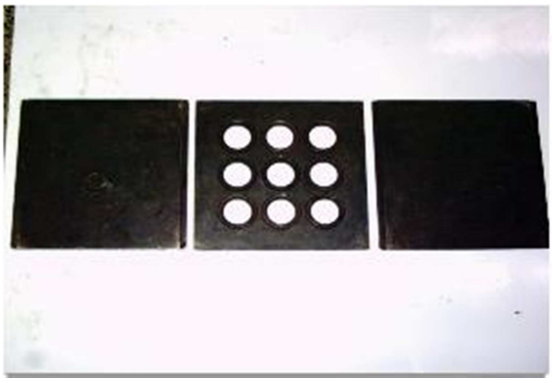

Fig 3. *Mould for testing hardness.*

Equipment for Hardness Measurement: The International Hardness test is used in measurement of the penetration of rigid ball into the rubber specimen under specified conditions .The measured penetration is converted to the International Rubber Hardness Degrees (IRHD) as shown in Fig. 4.

The scale of degrees is so chosen that zero represents a material having elastic modulus equal to zero and 100 represents a material of infinite elastic modulus. Test was carried out according to ASTM D1415 specifications.

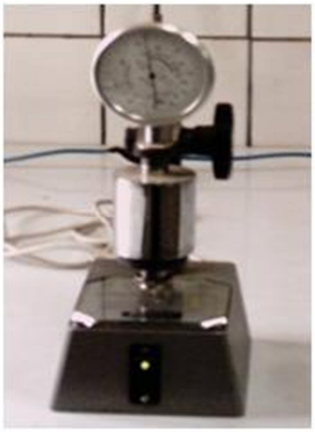

Fig 4. *Equipment of hardness.*

3. Results and Discussion

Fig.5 and Fig.6 shows the relation between the change hardness and PVC weight added to the main recipe after immersion in oil and water respectively.

We see that, the blends is having weaker Hardness property than pure Polymer, where the Hardness will decrease with exponentially relation during the immersion period in the oil and water, because of the penetration of oil and water molecules which increase the extending between the main chains and cause the weakening in secondary forces of (vander walls) and crosslink so that the Brownian motion of molecular chains will increases and this results agrees with other the at of workers [11].

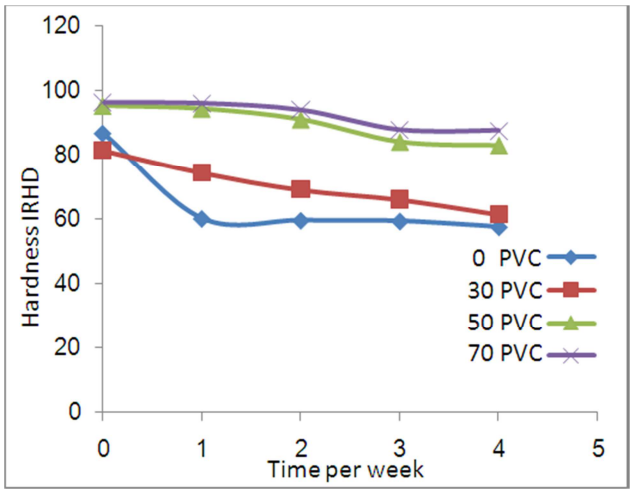

Fig 5. *The change in Hardness weekly during immersion in oil.*

At last the result is hardness decreasing. By increasing PVC content in NBR Hardness will decrease due to decreasing in Carbon black which presents in NBR that attracts Hydrocarbon and water molecules and cause changing in volume, and weight [12].

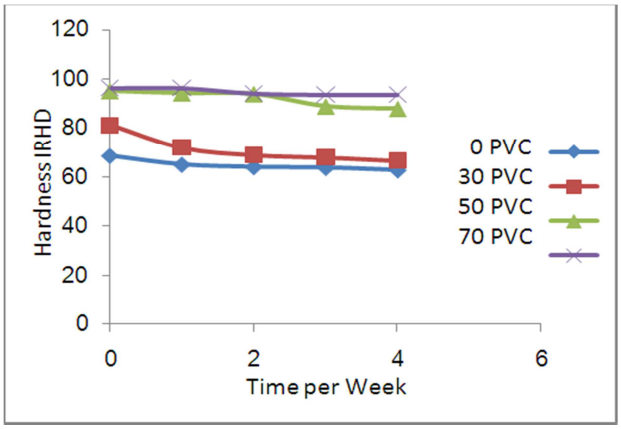

Fig 6. *The changing in Hardness weekly during immersion in distilled water.*

4. Conclusion

This paper introduces a new study of PVC - Acrylonitrile butadiene rubber (NBR) Blends .The hardness of pure polymer better than for blend, where the will hardness of blends decrease after immersion in oil and water and continue to decrease with the increase in the proportion of PVC additives to the rubber, as well as a decrease in hardness when immersion in oil greater than when immersion in water.

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