POLYMER COMPOSITES BY RECLAIMING RUBBER WASTES RESULTING FROM FINISHING THE RUBBERIZED ROLLS USED IN PRINTING INDUSTRY

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Valţurile metalice cauciucate utilizate în industria poligrafică, sunt realizate dintr-un amestec de cauciuc nitrilic, iar în procesul de finisare rezultă o mare cantitate de pudretă de cauciuc cu dimensiunile particulelor sub 1 mm. Din pudreta de cauciuc rezultată ca deşeu, s-au realizat compozitele polimerice pe bază de pudretă şi policlorură de vinil plastifiată, constituind noi tipuri de materiale cu proprietăţi de elastomer şi mase plastice, care se pot prelucra prin metodele specifice materialelor plastice şi se pot utiliza în diverse domenii ale economiei. S-au realizat compozite polimerice prin introducerea pudretei de cauciuc în topitura de PVC plastifiat. Cantitatea de pudretă de cauciuc nitrilic introdusă in 100 părţi de PVC a fost : 0 (proba etalon), 10, 30, 50, 70, 90, 110, 130 si 150. S-au studiat proprietăţile fizico-mecanice ale compozitelor polimerice obţinute.

The rubberized metallic rolls used in printing industry are commonly covered with a nitrile rubber blend and when finishing them a great amount of rubber powder with particle size less than 1 mm is yielded. Some polymer compounds of the above powder and plasticized polyvinyl chloride were prepared, constituting new materials with elastomer and plastic characteristics which can be processed by specific plastic techniques and used in various economy sectors. Polymer composites were prepared by mixing the rubber powder in the melted plasticized PVC. The amount of nitrile rubber wastes included in 100 parts PVC by weight was as follows: 0 (sample for control), 10, 30, 50, 70, 90, 110, 130 and 150 parts. The polymer composites obtained were tested for their physical-mechanical characteristics.

Keywords: polymer composites, nitrile rubber wastes, plasticized polyvinyl chloride, thermoplastic materials.

Introduction

Rubber wastes are generally non-biodegradable, being thus a major problem of environment protection. Rubber scraps resulting from the manufacture

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of tyres and technical rubber goods can be reclaimed efficiently by employing them in manufacture of thermoplastic elastomer composite materials [1-9]. These composites can be used as thermoplastic material substitutes. Such substitutions can result in lower costs because of savings in thermoplastic materials while enabling the industrial rubber wastes to be reclaimed. Moreover, the manufacture of such materials yields no wastes because of the spews and refuses being recycled. These composite materials are processed by procedures similar to those used in processing plastics and rubber blends (pressing, injection, extrusion, etc.).

Various sized rubber particles obtained from vulcanized rubber scraps can be used in modifying some materials like as low density polyethylene, polypropylene, polyurethane, polyvinyl chloride etc. Rubber particles are commonly included at a level of 5-7% in the thermoplastic material matrix by preparing a batch or by melt extrusion (preferably with a two-screw extruder), resulting in pellets used after wards in preparing a compound. A large variety of rubber particles can be obtained by buffing and cryogenic grinding the tyres, chopping and buffing footwear soles. The characteristics of the resulted compound are dependent on the particle size, elastomer type and recycled material level. In the present work we propose a new reclaiming method for the rubber wastes resulting from correcting and finishing the rubberized metallic rolls used in printing industry. The nitrile rubber powder with particle size less than 1 mm may be used for preparing composites with plasticized polyvinyl chloride.

Experimental

Materials used to obtain the polymer composites based on plasticized polyvinyl chloride and vulcanized nitrile rubber powder are as follows: vulcanized nitrile rubber powder obtained by buffing the rubberized metallic rolls when correcting them, PVC KW 58, PVC plasticizer (DOP), PVC stabilizer (LGR 8008), zinc stearate and antioxidant (Univil 5050H).

To obtain polymer composites the following processing operations were performed:

1. ***Raw material and material analysis;*** the nitrile rubber powder (NBR-butadiene acrylonitrile rubber) has resulted from the manufacture of rubber covered metal rollers used as replace parts in printing, textile and metallurgical industries. It was subjected to chemical tests and the results are shown in Table 1.

Table 1.

Rubber powder characteristics

Ref. no.	Characteristic	Value
1	Acetone extract, %	23.86
2	Ash, %	19.61
3	HCl insoluble matter, %	8.85

Acetone extract value (23.86 %) reveals such matters as free sulphur, curing accelerators, antioxidants, resins, plasticizers, lubricants and monomers being present in the elastomers.

Ash value (19.61 %) reveals the presence of such fillers as metal oxides (zinc oxide), chalk precipitate and other passive fillers.

HCl insoluble matter value (8.85 %) reveals the active filler such as silica precipitate being present in the rubber blends used in preparing rubber waste powder.

2. Material dosage: materials are dosed according to the recipes

3. ***PVC plasticizing;*** this step was performed in a Brabender Plasticorder, in a 2L recipient. The ingredients were added in the following sequence:
   - PVC + PVC stabilizer + zinc stearate + antioxidant
   - DOP added gradually while mixing

   and the processing variables were rotational speed 70-100 rpm and blending time: 10-25 min.

4. ***Preparing the experimental polymer composites*** based on plasticized PVC and NBR rubber powder and the control (with no recycled rubber powder) on the laboratory electrically heated roller mill. In this step the process variables were temperature range 140-170^{o}C and 1:1,24 the value of friction coefficient.

   The ingredient adding sequence has a total time duration of 15 – 30 min., as followings:
   - plasticized PVC: 7-15 min.
   - rubber powder: 5-10 min.
   - homogenization and removing from the roller mill: 3-5 min.

5. ***Samples preparation*** from the resulted polymer composites. In order to test the polymer composites for their characteristics they were made into plates by compression in a laboratory electrical press.

Results and discussions

We have studied a series of polymer composites, where the amounts of nitrile rubber included in 100 parts PVC (by weight) were: 0 (sample for control), 10, 30, 50, 70, 90, 110, 130 and 150 parts. The formulations for the prepared blends as well as the resulted physical-mechanical characteristics are shown in Table 2.

Table 2.

Formulations and characteristics for the polymer composites based on plasticized PVC and vulcanized NBR rubber powder.

Ref. No.	Ingredient	Control	R10	R30	R50	R70	R90	R110	R130	R150
1	NBR rubber powder, g	0	15	45	75	105	135	165	195	215
2	Plasticized PVC,g	233	233	233	233	233	233	233	233	233
Physical-mechanical characteristics measured in normal conditions										
1	Hardness, ºShA	80	78	76	75	74	74	67	64	62
2	Elasticity, %	7	7	7	7	7	8	8	8	12
3	100% modulus, N/mm^2	9,3	10,4	6,2	5,1	4,7	3,8	3,5	3	2,6
4	Tensile strength, N/mm^2	13	13,5	11,1	10,6	8,5	10,4	7,4	7,6	5,9
5	Elongation at break, %	220	180	287	300	273	393	300	340	287
6	Residual elongation, %	25	16	21	20	16	17	13	12	8
7	Tear strength, N/mm	76	65,5	59,5	56	52,5	40	46,5	45,5	34
8	Specific gravity, g/cm^3	1,03	1,02	0,99	1,03	1,23	1,23	1,22	1,21	1,19
9	Abrasive resistance, mm^3	106	123	135	141	165	139	147	162	172
Physical-mechanical characteristics measured after accelerated ageing (168hx70ºC)										
1	Hardness, ºShA	84	81	76	74	74	66	66	63	60
2	Elasticity, %	7	7	7	7	7	8	9	9	12
3	100% modulus, N/mm^2	9,5	9,8	6	5,4	4,9	3,8	3,6	3,2	2,7
4	Tensile strength, N/mm^2	12,2	13	9,9	9,9	9,6	10,3	7,7	7,3	6,5
5	Elongation at break, %	220	233	273	300	287	373	293	313	313
6	Residual elongation, %	23	15	19	19	16	16	15	11	11
7	Tear strength, N/mm	68	66	59	50,5	53	43	50	39	31,5

By including rubber waste powder in the rubber blends the characteristics are modified as following:

- Hardness is lowered from 80 ShA down to 62 Sh, owing to the plasticizing action of the nitrile rubber powder on the PVC ;
- Tensile strength and tear strength are decreased as the rubber powder level increases, however, at a level of 150 parts powder and 100 parts PVC these values are good enough, so that such polymer composites can be used in making a large range of products;
- Elongation at break increases from 220 % up to 393 % followed by a light decrease, as the rubber powder level is further increased. Generally, this result of the reduced values of the polymer composite physical-mechanical characteristics is correlated with an increase in powder level;
- Elasticity of composite shows an increase with the increase in rubber powder level above 40 %, thus revealing the elastic filler action of the powder;
- Behaviour at accelerated ageing is good.

The obtained results evidenced that the additive polymer composite characteristics are dependent on the ingredient characteristics and ratio (in volumes). Thus, hardness, tensile strength, as well as tear strength decrease, whereas the elongation at break increases, as the content of the rubber powder increases. This reveals rubber powder to impart elastic characteristics to the resulted polymer composites, therefore, it is an elastic filler.

All these experimental results prove that the polymer composites based on NBR rubber powder and plasticized PVC were prepared by melt blending them at a temperature closed to the melting point of the thermoplastic matrix can be processed by injection, extrusion, etc.

The resulted thermoplastic polymer composites can be processed by extrusion, injection, and compression molding. The use of such polymer composites removes curing operation with high power expenditure and noxious gas release. Furthermore, the processing is highly reduced resulting thus in lower costs, both because of use of lower cost materials and simplified processing equipment in continuous flow. Also, this is an efficient method for reclaiming rubber wastes. The resulted polymer composites can be used in the manufacture of a large range of products, like as hoses, gaskets, shoe heels, joint packings, slab pavements in sport halls etc., with competitive characteristics as compared to the similar products from virgin materials.

Conclusions

New polymer composites were prepared from the rubber powder obtained from used rubberized metallic rolls used in printing industry and plasticized PVC by melt blending at a temperature dose to the melting point of thermoplastic matrix. Their characteristics were tested showing parameters for a good injection and extrusion. The method is efficients for reclaming rubber wastes.

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