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Reclaiming EPDM waste rubber by various techniques

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Abstract

Ethylene–propylene–diene rubber (EPDM) is used to manufacture various automotive parts and disposal of these parts is a problem. An industrial autoclave, an industrial twin screw extruder and a microwave apparatus with the aid of 2-mercaptobenzothiazoledisulfide (MBTS) and tetramethylthiuram disulfide (TMTD) devulcanizing agents and aromatic and paraffinic oils, were used to devulcanize the waste powder from discarded EPDM automotive parts. The devulcanized products formulated in a common formulation for the automotive rubber strips and then revulcanized with a semi-efficient (SEV) vulcanization system. The viscosity, cure and mechanical properties of the compounds were subsequently determined. This study showed that waste rubber was successfully devulcanized with the aid of chemicals and paraffinic and aromatic oils for all employed devulcanizing techniques. The oils had different effects on the devulcanization of the waste powder and MBTS was more efficient than TMTD. Therefore, a new effective recycling routes for the waste EPDM powder in the automotive rubber strips is now available.

Keywords: Devulcanization , EPDM rubber, Autoclave, Microwave, Twin screw extruder, MBTS, TMTD, Oil

Introduction

Recycling of EPDM waste rubber can involve reprocessing it into its virgin form by breaking the crosslinks between the polymer chains (devulcanization), or, reusing the waste rubber in a new form. There are various difficulties associated with recycling EPDM rubber. These include the low solubility of most devulcanizing agents in rubber and presence of a higher percentage of stable monosulfidic crosslinks in the network [1]. The energies required to break monosulfidic,C-S, polysulfidic S-S and peroxide C-C bonds are 270, 240 and 345 kJ/mol, respectively [2]. Isayev et al. [3-4] investigated the devulcanization of various rubbers, including EPDM in a reactor consisting of a single screw extruder and an ultrasonic source on the die. The effect of processing parameters and ultrasonic conditions on devulcanization were reported. Mouri et al. [5] used a chemicomechanical method, involving simultaneous use of devulcanizing chemical agents and shear action. The devulcanization efficiency was increased by the addition of the devulcanizing agents during the shearing action [,1,5,6,7]. The devulcanizing agents were organic disulfides, mercaptanes and aliphatic amines.

Experimental

Material -Waste EPDM rubber powder was obtained from the Part Lastic Company. This powder was a mixture of several aged and new automotive rubber with an average particle size less than 1 mm. In the first stage, several aged and new automotive rubber with an average particle size less than 1 mm. In the .

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first stage, the oil content was extracted. In the next stage, thermogravimetric analysis was used to determine the composition of the acetone-extracted waste rubber powder (Table 1).For devulcanizing the waste powder, different amounts of aromatic and paraffinic oils as well as TMTD and MBTS were added to rubber powder and then devulcanized in several equipments, including an industrial autoclave, an industrial twin screw extruder and a microwave. Finally, the devulcanized samples were revulcanized. with a semi-efficient (SEV) vulcanization system and the cure and mechanical properties were subsequently determined.

Table 1- Physical properties and composition of EPDM waste powder after oil extraction by acetone

Property		Amount
Sol content (%)		0.5
Density (gr/cm^3)		1.4072
Crosslink Density (mol/m^3)		186
TGA	Others (%)	15.45
	Carbon black (%)	43.60
	EPDM(%)	38.88
	Left oil	2.07

Results and Discussion

An EPDM waste rubber powder that was a mixture of several aged and new automotive rubber components with an average particle size less than 1 mm, was successfully devulcanized with the aid of chemicals and paraffinic and aromatic oils in all employed devulcanizing techniques (Figure 1). It is clear from the results, namely, Fig 2 that a portion of the virgin rubber in the common formulation for the automotive rubber strips can be replaced without any adverse effect on the viscosity, cure and some of the mechanical properties of the rubber.

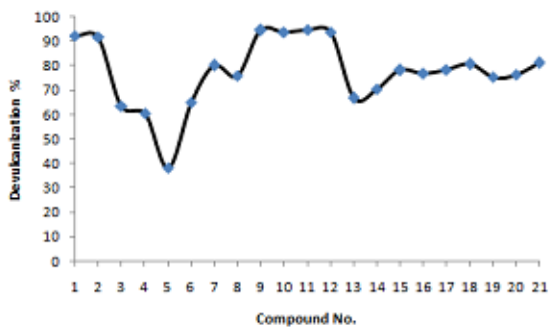

Fig 1.Devulcanization % for prepared compounds

Conclusion

Therefore, this may create a new routes for the recycling and reuse of the automotive EPDM waste powder.

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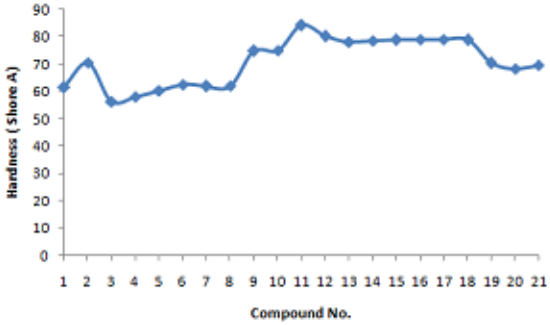

Fig 2. Hardness (Shore A) for revulcanized samples

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