Effect of polymers on the damping capacity of automotive bitumen anti-vibration insulators

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Abstract

Sound and vibration damping in automobile industry cause manufacturers to use insulators in automobile parts. High performance polymers are the best choice for noise reduction application. The addition of commercial polymers to bitumen base insulators of Ayegh Khodro Toos (AKT) Co improved their performance. Effect of polymers such as styrene-butadiene-styrene (SBS), styrene butadiene rubber (SBR) and butyl rubber with different weight percentages (2, 4, 6 and 8 w%) was studied in laboratory scale (3.5 kg product). Butyl rubber showed the highest vibration absorption (about 27%) among the polymers studied. Generally, the higher the concentration of the polymer used, the lower tensile strength, elongation at break and also the higher of damping was obtained.

Keywords: insulator, polymer insulator, bitumen, vibration absorption, damping

Introduction

Bitumen insulator products are widely used in the automotive and commercial vehicle market due to their performance and low cost [1]. Anti-vibration products are utilized to minimize noise and vibration for vehicle occupants and operators, as well as improving longevity and reliability of electrical and mechanical components [2]. Sheets are manufactured from bitumen, synthetic polymers, and minerals to create flexible and viscoelastic materials. Polymers such as Low density polyethylene (LDPE) [3], styrene-butadiene-styrene copolymer (SBS) and ethylene-vinyl-acetate (EVA) were used to provide anti vibration properties for bitumen insulators [3]. In a study to reduce noise and vibration using a polyurethane foam insulator, good results suitable for automobile industry were obtained [4]. Also, in another study, the sound absorption properties of nonwoven polyester/polyethylene were investigated and improved noise absorption properties were revealed [5]. Researchers investigated low weight, high elastic thermal and sound insulators as well as used polyether as main material of insulators [6]. Furthermore, there are another polymers used as sound absorption and damping like polyurethane/epoxy interpenetrating polymer networks [7] and polyurethane/poly(methyl methacrylate) [8]. Besides, use of fillers to increase mechanical properties and durability, for example, calcium carbonate [9] and palm slog [9] also is common.

In this work, polymers such as SBS, SBR and butyl rubber were used to improve anti-vibration and sound absorption of bitumen insulator.

Experimental

Bitumen (21%), carpet fiber, polyethylene (PE) granule and styrene butadiene rubber (2, 4, 6 and 8 w%) were used, and in some cases, SBS and Butyl rubber were used instead of SBR with the same weight percentage. The other chemicals were obtained from AKT Co. Calcium carbonate with mesh 400 was supplied by Omnia Pars Co. In this process, bitumen, PE, calcium carbonate, SBR and the other chemicals were added and mixed in one stage to obtain the insulating compound. The mixing process was

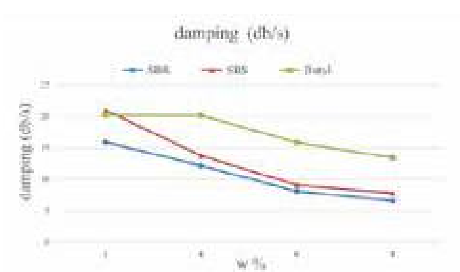

Fig. 1. Effect of polymer concentration on noise damping

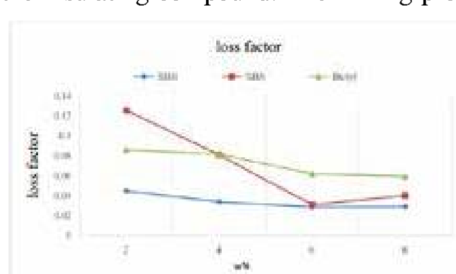

Fig. 2. Effect of polymer concentration on loos factor

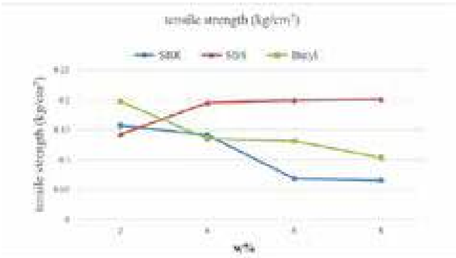

Fig. 3. Effect of polymer concentration on tensile strength

carried out at the temperature of 110 for 35-40 min. The mixture was completely mixed to obtain a relatively soft homogenous compound with high viscosity.

Results and Discussion

Study on the effect of SBS, SBR and butyl on the damping properties showed that the highest damping capacity belonged to butyl polymer. The highest damping (about 27%) was obtained at 4 w% (Fig 1). This behavior is due to isobutylene pendant group of the butyl rubber which can lose lots of energy [11].

However, using SBS (2 w%) provided the highest loss factor (about 0.1260) (Fig. 2). The benzene ring of the polymer is responsible for adsorption of heat, and consequently increasing loss factor. No shrinkage was observed in the compounds containing SBS (Table 1).

No regular behavior was obtained for tensile strength using all of the studied polymers in the compound. SBS caused to increase tensile strength to a limited value (about 0.2 kg/cm2) (Fig. 3). However, butyl rubber decreased the tensile strength from 0.197 to 0.103 kg/cm^2 (Fig. 3). The higher the concentration of the polymers, the higher elongation at break was obtained (Table 1).

Conclusion

Using of the polymers (SBS, SBR, butyl) up to 4 w% in bitumen insulating compound reasonably affected the damping capacity, which is the main characteristic of insulators. Among the polymers used, butyl rubber showed the highest damping capacity.

Table 1. Results for insulator samples prepared in this study

No.	polymers	w%	Elongation (%)	Damping (db./s)	Shrinkage (mm)
1		2	31.9	15.91	1
2		4	35.16	12.15	1
3	SBR	6	69.4	8.06	1
4		8	73.1	6.56	1
5		2	22.7	20.99	0
6		4	25.3	13.74	0
7	SBS	6	26.6	9.07	0
8		8	40.9	7.77	0
9		2	12.5	20.21	0.5
10		4	22.5	20.15	0
11	Butyl	6	28.7	15.85	0
12		8	31.9	13.43	0

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