SHUNGITE EFFECT ON SOME PROPERTIES OF ELASTOMERS

A.B. Solovieva[1], L.E. Neschadina[1], N.N. Rozhkova[2] and A.Z.Zaidenberg[2]
[1] Institute of Chemical Phisics Russian Academy of Science, Moscow, Russia
[2] Institute of Geology Russian Academy of Science, Petrozavodsk, Russia

Introduction

Shungite rocks are an ancient Precambrian carbonaceous formations widely spread in Karelia, Russia. They have an attracted interest because of their high carbon content and unusual forms of natural carbon [1]. Carbon was found in almost all rocks of this region. Shungite rocks were divided into five types according to their carbon content [2]. Some rocks consist of almost pure carbon up to 98 wt.% (type I). The most widely spread are shungite rocks of type III (carbon content 20-35 wt.%). Carbon with structuring ability in polymeric vehicles were found in lydite (type V) with carbon content less than 5 wt.% [3]. Based on the structural investigations the shungite carbon was characterised as X-ray amorphous. Its main feature is the presence of globules (fullerene-like formations that are typically up to 10 μm in size), observed in the various types of shungite rocks [4]. Apart from the carbon structure peculiarities, shungite differs from other natural carbons with content of microelements and products of extractions of organic solvents which were analysed [5]. Recent investigations showed the possibility of shungite powder replacing of both carbon black and silica in some elastomers [6].

The aim of this communication is to report new results on shungite filled elastomers and to check up the idea that the specific properties of shungite filler differ it from other carbonaceous materials are stipulated by the properties of shungite carbon and the structure of the rock itself.

Experimental

This work presents the results of studying of physical mechanical and technological properties of shungite filled elastomers (nitriloacryl butadien rubber (NBR), ethylene-propylene rubber (EPR), butyl rubber (BR), isoprene (IR) and fluorine rubbers (FR)).

Powders of three types of shungite rocks were used as a filler in order to determine the shungite carbon influence on the properties of the elastomers. Table 1 represents the composition and main physical chemical characteristics of these fillers.

Table 1. Some physical chemical characteristics and composition of studied fillers

	Type III	Type I	Type V
Carbon content, wt. %	28 - 32	87 - 98	2-4.
The mineral part composition, wt. %			
SiO_2	57.0 -66.2		95-98
Al_2O_3	3.20- 4.45		
TiO_2	0,.16 - 0.3		
Fe_2O_3 +FeO	1.0 - 2.3		
MgO	0.4 - 0.8		
CaO	0.07- 0.3		
K_2O	0.8 - 1.6		
Na_2O	0.11- 0.3		
MnO	0.01- 0.02		
Sulfur content, wt. %	0.2 - 0.7	0.4-0.8	0.2-0.5
Particle diameter, μm	5-30	4-40	1-20
pH of water suspension	4.69 - 5.20	5.6- 6.5	6.0-6.7
Water content, wt. %	0.2 - 0.5	0.4-1.0	0.1-0.3
Specific surface, m^2/g	30-50	40-75	50-80

Compositions were prepared on laboratory rolls in one stage with further pressing at 160 ^{0}C . Sulfur systems were used as curative for all the rubbers (but for the FR bis-phenol system was used).

Mechanical characteristics and Mooney viscosity were determined by standard methods. An equilibrium swelling of cross-linked rubbers was carried out in heptane at the ambient temperature. Adhesion of compositions to steel wire were measured by the method described in [7].

Results and Discussion

Table 2. Some properties of BNR-40, containing shungite of different types (Sh) and carbon black

Properties	Carbon black	ShI	ShIII	ShV
Mooney viscosity at 120 ^{0}C, arb.unit	52.0	50.0	25.0	60.0
Tensile strength, MPa	14.0	12.0	14.0	11.5
Elongation, %	750	880	830	700
Hardness , arb.unit	58	60	62	55

Shungite improves the mechanical and technological parameters of filled elastomers, namely, viscosity of polymer blend and relative elongation comparing with furnace carbon black . Some properties are listed in the

Table 2. The most effect among the investigated fillers was noticed for the type III shungite. This shungite is characterised by the inseparability of carbon and mineral parts after grinding up to powder with the average particle dimension about 3 μm.

As usual, an addition of filler into rubber reduces the polymer chain mobility, increases durability and decreases the elongation ability. The shungite peculiarity as a filler in contrast to others is the improving of both mentioned properties. Figure 1 (a,b) illustrates these results for the investigated rubbers.

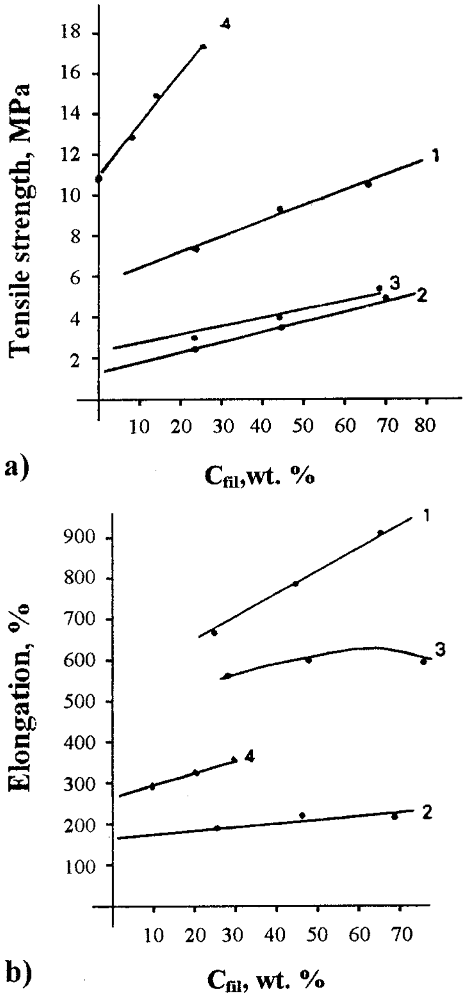

Figure 1. Dependence of strength (a) and relative elongation (b) on shungite (type III) content (wt.%) for the standard rubber blends: 1-IR, 2-EPR, 3-BNR-26, 4-FR

The effect observed may be because shungite presence does not decrease molecular mobility but increases it. This was checked up by measuring of the swelling of cross-linked shungite filled rubber in heptane vapour. As a rule, the fillers reduce the swelling in solvent vapour. Shungite effects on the rubber in another way than other fillers. The swelling of shungite-filled EPR (for example) increases with shungite content (up to 25 wt. % of shungite). This effect is known to be connected with increase of adhesion of elastomers to various surfaces. The adhesive strength for BR with different fillers is presented in Table 3.

Table 3. Adhesion strength of filled BR to the steel wire.

Strength, kg/cm^2	Carbon black	Sh.I	Sh III	Sh V
Destructive shift strength	0.94	0.7	0.89	0.5
Pulling-off strength	2.0	3.6	4.25	3.2

The data confirm the shungite ability to increase adhesion. The major effect was also demonstrated by type III shungite .

Conclusion

The data obtained show a relationship between the shungite rock composition and shungite behaviour as a filler in elastomeric matrix. The nature of the shungite behaviour is not quite clear. We suppose that observed kinetic effect of shungite could be connected with its carbon structure peculiarities and organic substance in shungite.

References

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