STUDY OF ZEOLITES AS FILLER IN THE RUBBER COMPOUNDS

Tatiana BAZYLÁKOVÁ, Darina ONDRUŠOVÁ, Mariana PAJTÁŠOVÁ,
Slávka ĽALÍKOVÁ, Milan OLŠOVSKÝ

Authors: ***Tatiana Bazyláková, MSc. Eng., Darina Ondrušová, Assoc. Prof. PhD., Mariana Pajtášová, Assoc. Prof. PhD., Slávka Ľalíková, MSc. Eng. Milan Olšovský, PhD.***
Workplace: ***Trenčín University of Alexander Dubček, Faculty of Industrial Technologies in Púchov***
Address: ***020 01 Púchov, Slovak Republic***
Email: ***bazylakova@fpt.tnuni.sk***

Abstract

Zeolites are microporous crystalline oxides with a high surface to volume ratio. Strictly speaking, they are aluminosilicates of form $M_x*(Si_{1-x}+Al_x)O_2*yH_2O$. Zeolites have many useful purposes. They can perform ion exchange, filtering, chemical sieve and filler. The zeolite clinoptilolite is a natural silicate mineral with internal channelling (Fig.1), a large surface area and high cation exchange capacity[1].

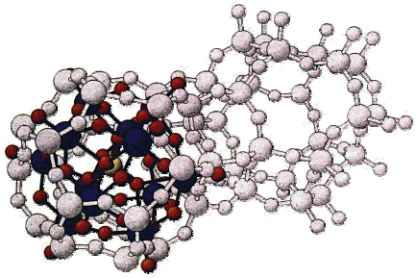

Fig. 1 *Structure of zeolite*

Key words

natural zeolites, thermal analysis, rubber compounds, physical-mechanical properties,

Introduction

Minerals can be only identified absolutely by x-ray analysis. The x-ray analysis determines the structure of the mineral.

Present paper deals with the preparation of modified rubber compounds in the presence of nanoadditive on the base of clinoptilolite and give the information about their rheology, vulcanization performance and physical-mechanical properties.

Experimental

The nanofiller of natural zeolite used in the experiments was obtained from region of Majerovce SR. It was ground and fraction of 0 - 0,2 mm was selected.

Individual amounts of mixed components and used conditions are given in the Table 1. Sample 1 – modified rubber compound with the substitution of all amount of filler clinoptilolite. Sample 2 – modified rubber compound with the substitution of 1/2 amount of filler clinoptilolite.

Selected sample of newprepared modified rubber compounds were studied by methods of thermal analysis - DTA, TG. Differential thermal analysis and Thermogravimetry were measured in the temperature range of 40 °C – 900 °C with heating rate of 10 °C.min^{-1}. Rheology and vulcanization performances (M_L, M_H, t_S, t_{90}, R_V) of prepared rubber compounds with the addition of nanofiller – clinoptilolite were tested and physical-mechanical properties of vulkanized rubber was studied[2, 3]. The values of prepared modified rubber compounds was compared with the standard (comercial rubber compound).

CONDITION OF PREPARED MODEL RUBBER COMPOUND IN GRAMS Table 1

Ingredient of compound	standard	sample 1	sample 2
SMR 20	59,40	59,40	59,40
ZnO	2,73	2,73	2,73
CBS	0,89	0,89	0,89
N660	5,94	0	2,97
Zeolite	0	5,94	2,97
Sulphur N	0,89	0,89	0,89

Result and discussion

X-ray analysis of natural zeolite show that confirmed the major presence of clinoptilolite with structural formula (Na1,32K1,28Ca1,72Mg0,52). The XRD pattern of the natural zeolite sample is given in Fig. 2.

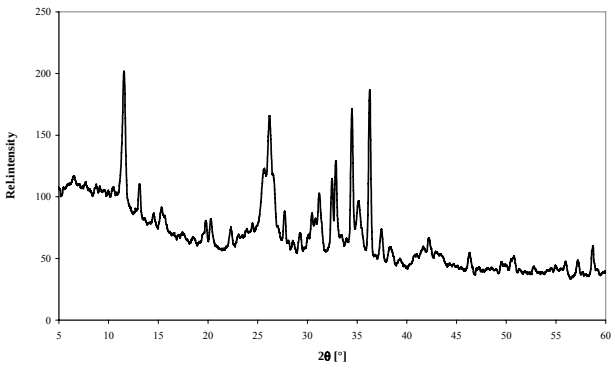

Fig. 2 *X-ray of natural zeolite*

From results of thermal measurements given in Fig. 3-4 follows a simillarity of thermogram in the case of sample 2 with the thermogram of standard. The thermal

decomposition of all studied rubber compounds was observed in the temperature range of cca 300 °C – 700 °C.

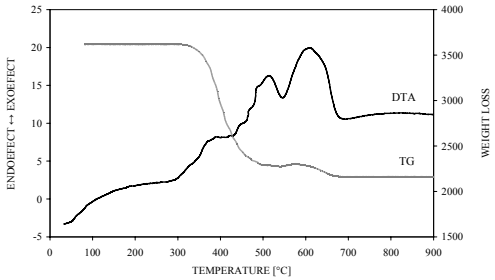

Fig. 3 *DTA-TG standard rubber compound*

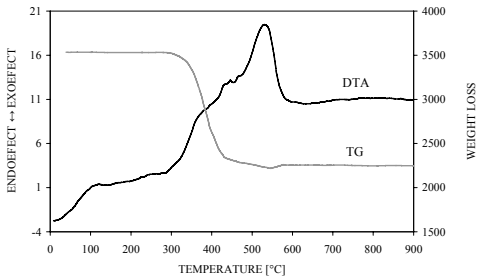

Fig. 4 *DTA-TG of sample 2*

The results of vulcanization performance are given in Table 2.

VULCANIZATION PERFORMANCE
OF MODIFIED RUBBER COMPOUNDS Table 2

	M_L [dN/m]	M_H [dN/m]	t_{02} [min]	t_{c90} [min]	R_v [min^{-1}]
standard	5,0	45,0	1,5	3,5	50,00
sample 1	4,0	38,0	5,5	7,5	50,00
sample 2	8,0	46,0	2,5	4,5	50,00

The values of vulcanization performance remitted, that the used type of zeolite influences as an inactive filler in compare with a carbon black (N660) in rubber compound. A viscosity decreases with an increasing amount of natural zeolite in rubber compound (see a lower values of M_L and M_H) and extend optimal time of vulcanization (t_{c90}). At sample 1, were is a complete substitution of carbon black is that more than 200 % and the scorch of time (t_{02}) is expressively higher. The values of rate coefficients (R_v), which characterize „activity“ of ingredients in compound are equal. Vulcanization curves had equally steep „gradient“, what indicate, that the used natural zeolite is partially also „active filler“. That can be caused by present of a little amount of oxides (mainly CaO and MgO). Both maybe use as an activators of vulcanization too. Their content is very little in compound, so don´t have distinct influence on vulcanization parameters. Further, content of SiO_2 is till 70 % in natural zeolite and this use as „inactive filler“, so called a diluent in rubber compounds[4, 5].

The measured values of physical-mechanical properties prepared vulcanizates are mentioned in Table 3.

PHYSICAL-MECHANICAL PROPERTIES OF PREPARED
VULCANIZATES Table 3

	Tensile strength [MPa]	Tensibility [%]	Modulus 300 [MPa]	Hardness [IRHD]
standard	13,17	685	5,77	47,6
sample 1	11,12	854	3,91	42,3
sample 2	13,65	774	5,29	44,0

The sample 2, where was the substitution of carbon black by natural zeolite 50 %, shows the best values of physical - mechanical parameters. The sample has the highest value of tensile strength and tensibility too, what can be caused by relative synergy between carbon

black and the used natural zeolite. The value of hardness is a bit lower than the value at standard, where was used only carbon black, what can be connected with lower „activity“ of used natural zeolite in compare with carbon black. The measured values of physical-mechanical parameters at sample 1 aren´t suitable of technological point of view. The sample has a lower value of tensile strenght to the prejudice of a high sensibility, what confirm of theory of high elasticity[6,7], but complete substitution of carbon black by this type of natural zeolite isn´t possible of point of view of rubber technology. The used type of natural zeolite is „inactive filler“ in this case.

Conclusion

From study of properties of modified rubber compounds with the addition of natural zeolite nanofiller follow that natural zeolite – clinoptilolite may be used for the application in the rubber compounds improving the properties studied.

Acknowledgements

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