APPLICATION OF ACCELERATED ELECTRON BEAMS FOR RUBBER AND POLYMER MODIFICATION.

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The radiation modification of polymer and rubber materials permits the proper changing of their characteristics to improve the operational and consumer properties of products. In particular, the radiation processing of polymer and rubber materials permits to increase their strength, wear-resistivity and to expand a range of working temperatures. Practical use of radiating updating polymer is possible in the various areas of manufacture, for example, graphic arts industry, automobile and tractor engineering, light industry and other.

The common feature of ionising radiation beams effect, in particular, electron, x-ray and bremsstrahlung on polymer chemical bands is a possibility of their braking and formation of chemically active radicals, spread throughout a processed material volume pursuant to distribution of an absorbed doze. The products of ionisation and excitation of molecules give an institute to new chemical bands, therefore changing the physics-chemical properties of an initial material. The process of macromolecules formation at the expense of free radicals connection permits to create the chains of complex structured polymer molecules. It results in improvement of elastic properties of a polymer material, expansion of a temperature range, in which it saves properties. However, except processes of molecules association during interaction of a polymer material with ionising radiation the processes of the molecules oxidenting and formations of products with shorter chains occur also. In view of this positive result (i.e. the improvement of operational properties of products manufactured from modified materials) can be received only at a determined ratio of products, formed as a result of these two processes, that is reached at quite determined value of an absorbed doze for each type of a material.

To research the polymer materials physical properties changing under electron beam radiation with energy 4...8 MeV and average current up to 100 μA were used for material processing. A conversion target was also used for creation of bremsstralung and mixed beams. However the efficiency of bremsstralung has appeared to be essentially smaller, than of an electron one.

A The nitrille rubbers modification.

The radiation-chemical modification of rubbers permits to improve considerably theirs limiting operational parameters. Thus the most essential increases appear for wear-resistivity (up to 5 times), limit of elasticity (up to 5 times) and working temperature range (up to 2 times). Such changes of the nitrille rubbers properties are stipulated by occurrence of additional cross-bands between polymer molecules under the ionising radiation beams influence.

For research of the rubber properties change under radiation modification the sample of rubbers marks 7-N068-1, IRP-3029, 7-IRP-1352, 7-V14 were used. These marks rubbers are widely used in automobile and tractor engineering, produced by industry of Russia. In particular, these rubbers are used for manufacturing various seals, shock-absorbers.

The main results of conducted researches on some marks rubbers properties changing are listed in the Table. These results are obtained for optimum values of absorbed dozes. It is necessary to note, that the range of an absorbed doze value variation, in which given parameters are reached, is about (30 ...50) % from the optimum value.

The obtained results show, that at all tested rubbers samples at an insignificant increase of a module of elasticity (i.e. increase of its rigidity) an essential increase of wear-resistivity and limit of elasticity is observed. In turn, the increase of a material limit of elasticity also increases the durability of products, manufactured from it, that works as seals and shock-absorbers.

The tests of bearings seals, made from rubber mark 7-N068-1 and been processed by electron beam, that were carry out at a specialised equipment have shown, that the such seals durability grows in 2 ...3 times in comparison with control samples.

B. The silicone rubbers modification.

The silicone rubbers are used in cases, when application of usual rubbers is not effective or is impossible because of significant deterioration of their properties. As a rule, it is connected with work at increased or lowered temperatures. The usual rubbers in these conditions either become very rigid and fragile (low temperatures), or become plastic with elasticity loss (high temperatures). The silicone rubber save serviceability in a wider temperature range: at lower and higher temperatures both.

In particular, pursuant to help data [1], the most widespread samples of the silicone rubbers serviceable (i.e. the changes of their properties are insignificant) at temperatures up to -35 ...-40 ℃ (see Fig.1). The radiating processing of the silicone rubbers results in improvement of their properties at low temperatures. A number of experiments on processing of the silicone rubber samples mark 9M4218 was conducted. The rubber of this mark is applied by the firm Caterpillar (USA) at seals manufacturing of the tractors.

The results of these experiments are shown in Fig.2. Here the graphs of a rubber module of elasticity relative value $E(t) / E_o$ va. sample temperature t for various values of an

absorbed doze (here the size of an absorbed increased from sample A to sample C) are plotted. The dependence of a module of elasticity on temperature in a range from -40 up to -80 ℃ for processed samples appears to be smoother in comparising with untreated ones. The 50 % decrease of module of elasticity for processed samples is observed at temperatures on 15 ...20 ℃ below, than for an initial material.

C. Kaprolon modification.

The kaprolon, as well as the rubber, is widely enough used in engineering for manufacturing of various details. In particular, it is used for manufacturing of cartridges of sliding bearings and gears. In this case a special significance is given to such characteristics of a material, as a sliding friction factor, limit of elasticity, wear-resistivity.

The researches conducted have shown, that at optimum absorbed doze values the kaprolon parameters increases as following: module of elasticity - at 20 % , limit of elasticity - in 4 times and wear-resistivity - at 60 % .

D. Polymer materials for a graphic arts industry.

In a graph art industry a metal and a photo polymer high forms are used in printing process. Photo polymer forms materials like cellophot and flexophot are used. Thus the photo polymer high forms cost appears far below the cost of metal ones. Besides this advantage of the photo polymer forms there are a number of essential defects: a significant wear (it means low durability), that is due to insufficient strength of the photo polymer material and low operating temperature. These defects do not permit to use given materials in some technological processes required increased working temperature. The radiating processing of photo polymer high seal forms give a possibility to increase a limit of elasticity of a material in 4 ... 5 times, and working temperature up to 200 ° C. Such change of the material properties enables to increase the forms durability in 50 and more times for application in usual conditions. Moreover after modification they can be used in processes, where untreated forms are disabled. In a number of cases, it permits a complete replacement of the metal forms by the photo polymer ones.

E. Shoe industry.

A thermoplastic polyurethane is used in a footwear industry for manufacturing shoes. The special researches were conducted to define the opportunities of the polyurethane physical properties improvement, in particular, the wear-resistivity increase, with the help of radiation processing. The experiments been accomplished show following results. The radiation processing provides a possibility to increase a material wear-resistivity in 1,7 ...2 times.

The other physics-mechanical properties of the material do not change. The processed products cost grows not more than on 15 ...20 %.

Thus, the conducted researches of electron beams effects on polymer and rubber materials have shown a possibility of essential improvement of their operational properties, such as strength, wear-resistivity, work temperature. The real values of the appropriate materials parameters change may be up to several times.

REFERENCES

[1] V.K.Knyazev, N.A. Sidorov et al. Radiazionnaya stojikost materialov radiotechnicheskich construkziji, M: Sov. Radio, 1976.

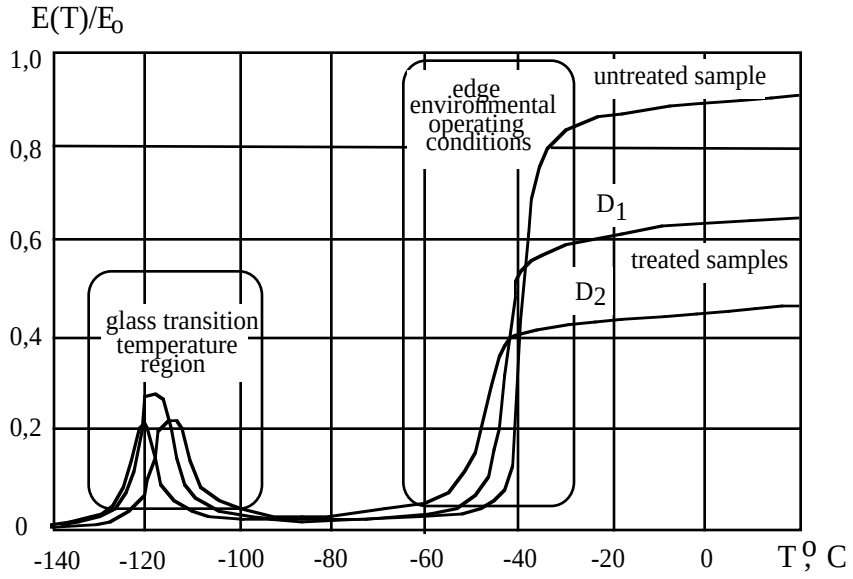

Fig. 1. The silicone rubber module of elasticity relative change E(T)/To vs. temperature T for various values of an absorbed doze (D1 < D2).

Material	Parameter increase, %		
	Wear-resistivity	Module of elasticity	Limit of elasticity
Rubber 7-N068-1	400 ...500	10 ...20	400 ...500
Rubber IRP-3029 7-IRP-1352	300	20 ...30	500 ...600
Rubber 7-V14	200	15 ...20	200 ...300

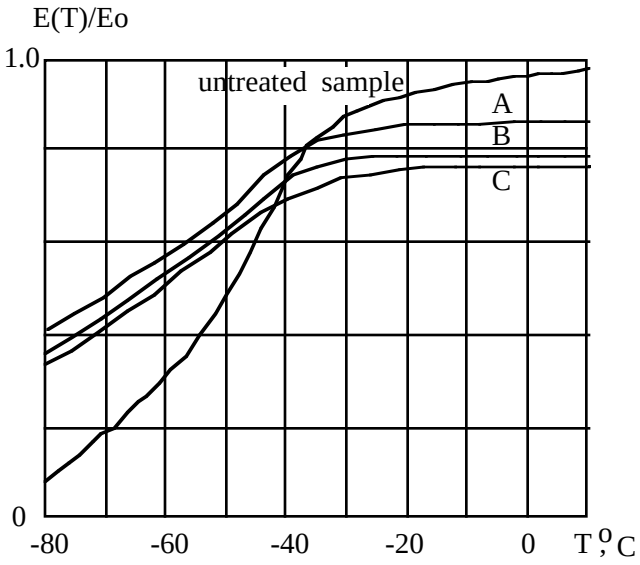

Fig.2. The silicone rubber (mark 9Ì4218, Caterpillar Inc.) module of elasticity Å(Ò)/Åî relative change vs. temperature Ò for various values of an absorbed doze of electron beam irradiation (absorbed doze increases from sample A to sample C)