Mechanical properties of polimer composites with Bentonite and Fishbone fillers

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ABSTRACT

The presented work presents the results of a study of the mechanical strength of composites of low density polyethylene with fish bone and bentonite fillers, depending on the volume content and type of fillers and relative to deformation. It was revealed that at relatively low values of mechanical deformation for biocomposites and composites with bentonite fillers, mechanical strength increases, reaching maximums, remains almost constant. The decrease in mechanical strength with fillers of fish bone and bentonite occurs with an increase in the volume content of fillers. The results show that with a variation of the composition and type of filler, samples with high mechanical strength can be obtained.

KEYWORDS:

Bentonite, fishbone,LDPE+x vol%Bentonite, LDPE+x vol%Fishbone, mechanical strength, mechanical tension.

I. INTRODUCTION

Bentonite is a clay-like mineral of sedimentary type with water-absorbing and adsorbing properties. Bentonites are successfully used in agriculture, steel industry, in the manufacture of cosmetics and perfumes, for household chemicals, have excellent absorbing properties, are widely used in the manufacture of various emulsions and additives that inhibit corrosion. At the same time, the cost of raw materials even the highest quality is much lower than that of vegetable and animal additives used in the production of household chemicals. Bentonite is also widely used in the oil industry. Products obtained during the refining of petroleum significantly improve their consumer qualities if they were previously cleaned with bentonite. The main properties of bentonite the ability to swell, increasing in volume 10-16 times.

The analysis of literature data shows that the fillers impart increased thermal and electrical conductivity to polymer materials, improve mechanical and electrical strength, and so on.

The use of fillers of different origin, in particular bentonite and fish bones are interest in the development of new types of composite materials. The choice of bentonite as a filler is associated with a low degree of study of its electrophysical characteristics, as well as the prospects of obtaining new sufficiently elastic thin-film composites. Composites with natural bentonite and fish bone fillers can have a wide range of properties and can be successfully applied in practice [1-4] and fillers of biological origin as fish bones increase the dielectric constant and decrease the dielectric loss. There is information about the effects of fish waste on surface structures and the physical properties of low density polyethylene [5,6], but information on the study of the mechanical properties of composites of the above types is missing. The purpose of this work is to obtain, phase analysis and study of the effect of bentonite and fish bone fillers on the mechanical strength of low density polyethylene.

II. EXPERIMENTAL METHOD

Polymer composites $(LDPE)_{1-x}$+$(bentonite)_x$ and$(LDPE)_{1-x}$+$(fishbone)_x$ were obtained by hot pressing at the melting temperature of the polymer matrix at a pressure of 15 MPa for 5 minutes. Samples was made in the form of a film, the mechanical strength of the compositions studied were investigated at room temperature [5-7].

Samples for the test for strength dependence of mechanical strength were cut from the film with a special knife in the form of a double blade with a working length of 10 mm and a width of 3 mm. With these measurements, there was a time elapsed from the beginning of application of the mechanical load to the moment of rupture of the samples at various mechanical stresses. As is known, the test sample is elongated during the experiment, its cross-section decreases, and the voltage at constant suspended weight increases. To maintain a constant voltage, a lever-type device is used, which automatically reduces the load acting on the sample as it lengthens. The principle of the installation is shown in Fig 1.

To compensate for the voltage during the test, the cargo P is not suspended directly to the sample, but by means of a shaped lever whose shoulder automatically decreases as the length of the sample increases (Fig.1). Assuming that the cross section of the sample decreases in proportion to the relative elongation, the volume remains unchanged, and whose shoulder automatically changes as the length of the sample increases, then for σ = const the shoulder should decrease with increasing deformation by the formula

$$R = R_0\left(\frac{1}{1+l_\varepsilon}\right)$$

where: l_ε is the elongation, R_0 and R are the projections of the radius of the vector on the horizontal axis in the initial and loaded positions. The thickness of the samples before the test was measured with the help of the device IZV-2 with an accuracy of 1 mkm.

The second high-voltage electrode 2 with a diameter of 10 mm had rounded edges. A close contact of the high-voltage electrode with the test sample was carried out with the help of a spring 4. As a high-voltage source, the Universal machine of the UPU-1M type was used. The required value of high voltage with a frequency of 50 Hz was applied to electrode 2, and electrode 1 was grounded. Samples for testing were made in a rectangular shape with dimensions of 40x50 mm. During the test, the sample was located between the electrodes.

Before the test, the thickness of each sample was measured by an IZV-2 instrument on 6-7 working sheets, after which the arithmetic mean value was found.

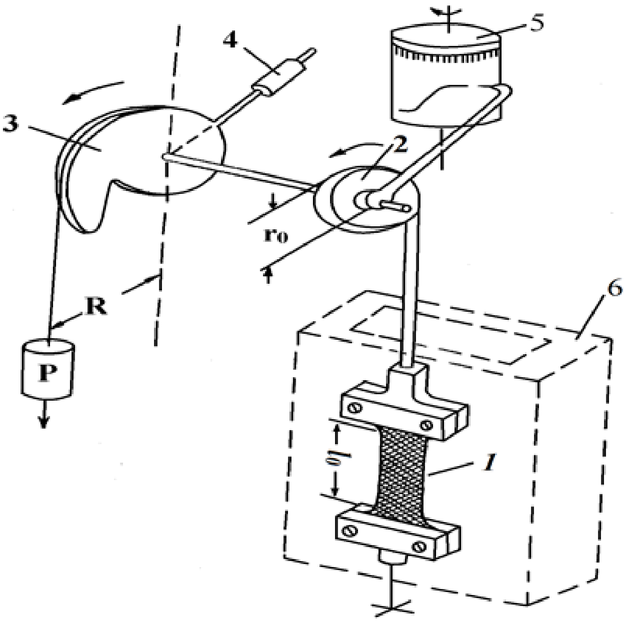

Fig. 1. Installation for determining the mechanical strength of composites. 1 - sample; 2 - block; 3 - a rotating disk; 4 - compensating cargo; 5-hour mechanism; 6 - temperature chamber.

III. RESULTS AND DISCUSSION

The character of the stretching curves of LDPE + xvol.%BE and LDPE + x vol.% FB composites is the same. The common for all curves is the presence of an initial steep section and a shallow part of the curve. The transition from the first section of the curve to the second is accomplished in some cases monotonically, and on some samples a curve with a weak maximum is obtained. Apparently, at the initial section, the shape of the elongation curves of the composites is due to a change in the internal energy. The deformation is mainly due to changes in intermolecular distances, valence angles, and interatomic distances. It is known that a high-elastic deformation are develops in a mechanically rigid body only under the action of sufficiently high stresses, in this case it is forcedly elastic deformation. The decrease in the slope of the curve $\sigma = f(\varepsilon)$ when approaching the maximum is also associated with the development in the sample of a forcedly elastic deformation.

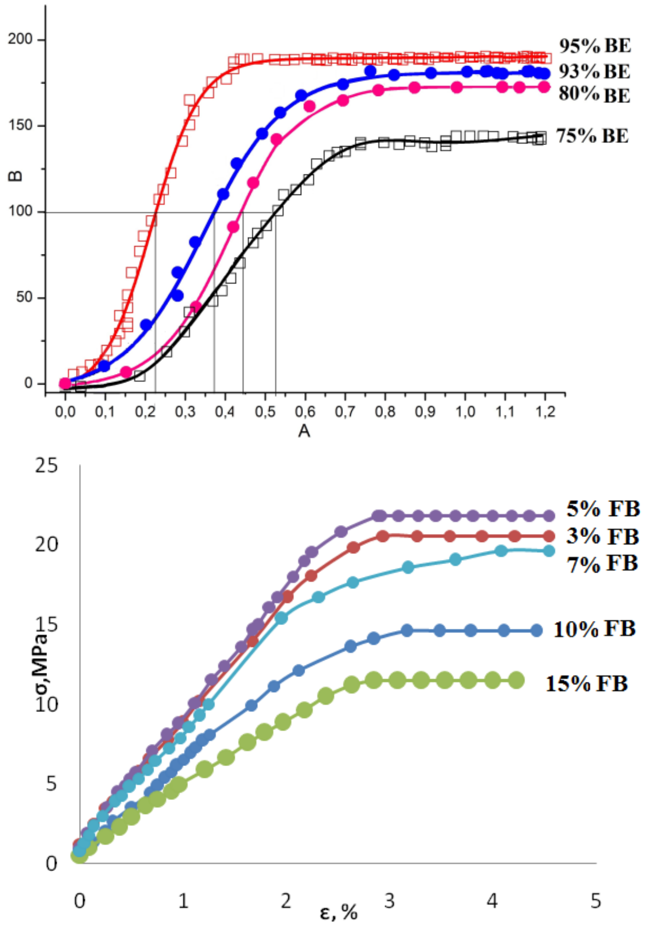

Figure 2. The stretching curves of LDPE + xvol.%BE (a) and LDPE + x vol.% FB (b)

The nature of the development of forced elastic deformation indicates that, like plastic, it is caused by stresses that cause the displacement of some layers of material relative to others. In most polymers, the onset of development of a forced elastic deformation is localized. In the presence of even a slight unevenness in the size of the sample, a local increase in voltage is created. It is at this point that the elastically deformed strain develops, since the rate at which this type of deformation grows strongly depends on the stress. The development of forced elastic deformation is accompanied by the release of heat. In the region of deformations corresponding to the maximum on the curves σ (ε) (Fig. 2), the formation of the so-called neck is observed. In samples in which there is no maximum on the strain curve, neck formation does not occur. On the canopy section of the tension curve, the stress remains practically constant. At this stage of deformation, the cross-section of the neck changes little, and the elongation of the sample occurs due to the propagation of the forcedly elastic deformation to the neighboring parts of the sample. This process is accompanied by an increase in the length of the neck.

The voltage drop on the curves $\sigma = f(\varepsilon)$ turns out to be much less or completely absent when calculating the voltage for the true cross section. If the voltage is calculated for the initial section, then the voltage drop is mainly due to the narrowing of the sample in the neck. Naturally, as the cross section decreases, the deforming force also decreases, but if this reduced value is referred to the initial section, then the voltage will decrease. A small drop in voltage is observed not only in tension, but also in compression, when the cross section of the sample does not decrease, but increases. Therefore, some weakening of the material associated with the formation of microfractures should be allowed. The presence of a horizontal pad on curve $\sigma = f(\varepsilon)$ is that in the composite materials studied, orientation hardening takes place. Indeed, in the stretched samples anisotropy of mechanical, including other properties occurs. When the degree of stretching is reached when the sample is hardened, the material that is noticeably hardening and increases σ, the development of the forcedly elastic deformation in the neck sharply slows down. The process of deformation occurs at the neck boundaries, where the cross section of the sample is reduced, i.e. tension has increased, hardening is still small.

IV. SUMMARY

In the present work were studied influence of mechanical stress and the volume content of fillers from bentonite and fish bone on the mechanical strength of low-density polyethylene. It was found that at low mechanical stress values and with low bentonite content, the mechanical strength of LDPE / bentonite and LDPE / fish bone composites increases.

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