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Polymer Composite Films Filled With Navbahor Bentonit

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Abstract: *This article presents the results of studies of the sorption properties of compositions based on bentonite from the Navbahor deposit and polyvinyl chloride (PVC) polymer.*

Keywords: puncture, exponential equation, two-phase heterogeneous system, agglomerate, deformation-strength characteristics

Introduction

Current trends in the development of thin-film technologies and the semiconductor industry inevitably lead to a decrease in the characteristic dimensions of the created structures [1-4]. In the modern world, the demand for polymer synthetic materials is steadily growing [11,12]. One of the large-scale synthetic polymers with a wide range of applications is polyvinyl chloride (PVC), which ranks third in terms of world production after construction plastics and polyolefins. A significant range of performance characteristics makes PVC indispensable for the production of packaging materials: various types of films, containers, etc. Due to its chemical inertness and stability, the most important applications of PVC as packaging, whether rigid, flexible or in the form of a tube, are the food industry and medicine [6-10].

Currently, there are several methods for the disposal of polymer waste, this is, first of all, incineration, burial. That is why it is urgent to develop compositions and technologies for obtaining polymer composites based on PVC, which have degradable characteristics that come into force after the end of the service life of products under the influence of external factors (soil microorganisms, light, oxygen, water, etc.) [5]. The development of materials that undergo accelerated physicochemical and biological changes in the natural environment, which are actively being introduced into modern production, is based on the principles of creating polymer composites modified either by biopolymers or mineral fillers. However, the introduction of fillers into PVC, which contribute to a more rapid decomposition of the material, is accompanied by a significant decrease in its performance characteristics [13]. Thus, the selection of the optimal technological parameters for obtaining degradable PVC films with a short life span and acceptable characteristics is one of the most important tasks of the transition to clean, environmentally friendly products for packaging.

Method of research

Micrographs of the studied materials were obtained by the methods of light field in reflected light and polarization contrast.

Result and discussion

The purpose of our work was to study the color and optical characteristics of polyvinyl chloride films filled with Navbahor bentonite.

It is well known that irregularities on the surface of a material arise, first of all, due to the resulting deformations of the upper layer of the film during processing. In the general case, the surfaces of the obtained polymer bentonite-filled polyvinyl chloride films have a small roughness, which increases on average by 1.5–3 times with an increase in the proportion of filler in the composite.

Figures 1 and 2 show micrographs of PVC films without filler and with bentonite concentration of 5 wt.% obtained in different modes.

As can be seen from micrographs when natural Navbakhor bentonite is introduced into PVC, agglomerates with sizes from 30 to 230 microns are formed, which leads to a less homogeneous and more rough surface of polymer films. Such PVC-filled films strongly scatter light. That is why the used inorganic filler-bentonite can be used as anti-blocking in the creation of PVC composite, giving less adhesion of the films to each other.

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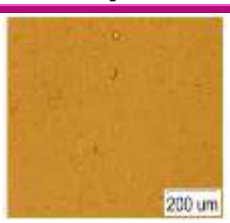
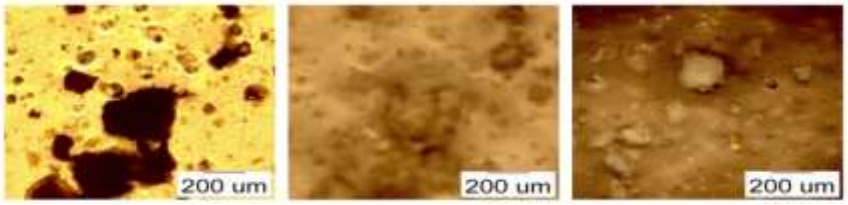


Figure 1
Photo of PVC film
without filling



a) b) c)

Figure 2
Photos of the surface of PVC films with bentonite
a concentration of 5 wt.% obtained by:
a) lumen; b) reflection; c) the reflection with polarizer

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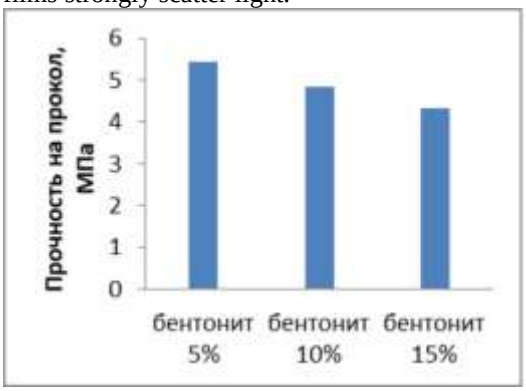
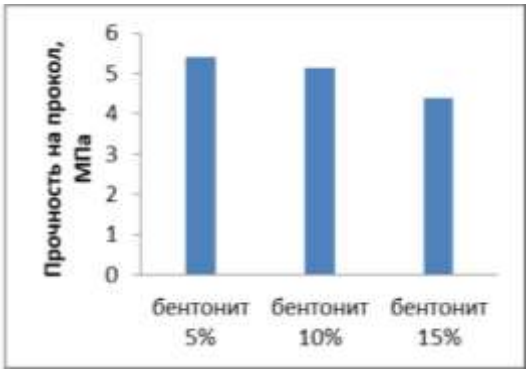
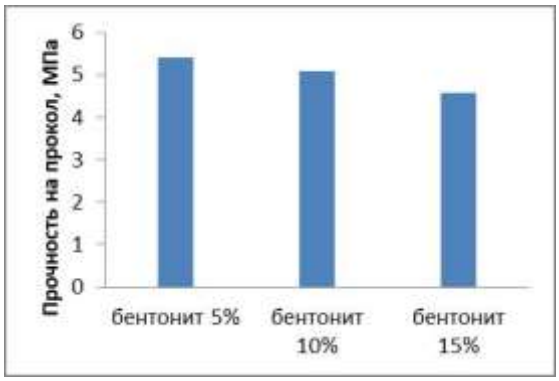


a



b



c

Figure 3 - Dependence of the puncture strength of PVC films on the proportion of bentonite in the composition at different rolling times, min:
a - 2; b - 5; c - 10

Figure 3 shows the dependences of the puncture strength of PVC filled with bentonite films, taking into account the rolling time.

The dependences of the puncture strength of polymer PVC films filled with bentonite are described by the following exponential equations:

time for rolling 2 min: $\sigma = 6{,}1\ e^{-0{,}1[B]}$;
for the time rolling 5 min $\sigma = 6{,}0\ e^{-0{,}1[B]}$;
for the time rolling 10 min $\sigma = 5{,}9\ e^{-0{,}1[B]}$,
where σ is the penetration resistance, MPa; [B] is the concentration of bentonite by weight %.

Figure 3 shows that an increase in the concentration of mineral-containing filler in the composition of PVC films leads to a decrease in the puncture strength: when processing on rollers for 2 minutes, when the filler is introduced, it is 2 times more (5

wt.% and 10 wt.%) the strength of the films decreased by 4.5%; when processed on rollers for 5 minutes with the introduction of the filler, it was 2 times more (5 wt.% and 10 wt.%), the strength of the films decreased by 5.7%; and when processing on rollers for 10 minutes with the introduction of filler, it was 2 times more (5 wt.% and 10 wt.%) the strength of the films decreased by 10%. This may be due to both the inhomogeneity of the resulting material, which has large local stresses with a large filling of PVC films, and the processes of thermal destruction of the PVC polymer matrix, as discussed earlier.

Conclusion

As a result of these processes, an increase in the rate of relaxation processes occurs, which contributes to a decrease in local stresses in the composite and, as a consequence, leads to an increase in the deformation and strength characteristics of the polymer composite [14].

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