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Use of Local Raw Materials to Reduce the Flammability of Polyethylene

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Abstract: The paper discusses ways to reduce the flammability of polyethylene film, which is part of a multilayer film material. The possibility of using organobentonite as a fire retardant has been studied. The physical and mechanical characteristics of the filled films were obtained. It has been shown that the introduction of organobentonite or zinc borate can increase the fire resistance of polyethylene film.

Key words: Polyethylene film, ammonium salts, tetrabromobisphenol, melamine, red phosphorus, kaolin, pumice, gypsum, perlite, montmorillonite.

One of the most important classes of non-metallic materials, both in terms of volume of application, and in terms of the number of materials included in it, and in terms of the number of technical problems solved with their use, are polymers. They have a complex of very valuable and sometimes opposing properties: high elasticity combined with strength comparable to the strength of metals, high frost resistance and at the same time temperature resistance, low density and excellent dielectric properties, and others.

The use of polymers allows:

- ✓ reduce the weight and material consumption of the product;
- ✓ reduce labor intensity and energy costs for manufacturing products;
- ✓ increase the reliability and durability of equipment;
- ✓ improve the operational characteristics of machines and mechanisms;
- ✓ increase the aesthetic appeal and comfort of products [1].

Experimental part. Multilayer film materials are widely used in many industries, including for special purposes). Currently, MIPP-NPO "Plastic" has developed a multilayer film material with radio-shielding properties, which includes, along with metallized polyethylene terephthalate film, polyethylene film). The structure of the material is shown in Fig. 1.

Polyethylene film, which is part of a multilayer material, does not always meet fire resistance requirements). Currently used flame retardants are halogen-containing additives, the destruction products of which are hazardous to the environment). Recently developed environmentally friendly systems - inert aluminum trihydrate and magnesium hydroxide - are effective only at high filling levels, which is not possible when producing films.

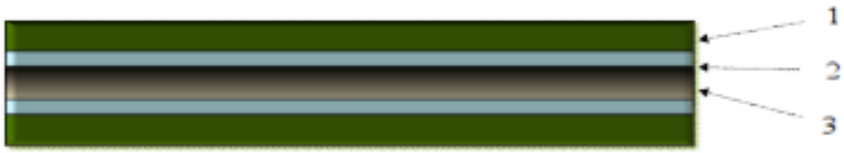

Fig. 1. Structure of multilayer film material:

1. PE film fire-resistant, 100 microns; 2. PU glue, 5 microns; 3. metallized PET film, 12 microns.

The presented studies were carried out to determine the possibility of increasing the fire resistance of multilayer film materials by using new classes of halogen-free flame retardants. The paper presents the results of modifying polyethylene film with fillers that reduce flammability.

LDPE 11503 – 070 was chosen as the objects of study. The following compounds were used as flame retardants: organobentonite nanosystem (montmorillonite modified with quaternary ammonium salts), tetrabromobisphenol A ($C_6H_2Br_2OH$-C_3H_6 - $C_6H_2Br_2OH)_2$ together with the synergist antimony trioxide (Sb_2O_3), tetrabromobisphenol and with the synergist zinc borate ($2ZnOx3B_2O_3x3,5H_2O$), melamine ($C_3H_6N_6$), melamine phosphate ($C_3H_9N_6O_4P$). Particular attention was paid to the introduction of a new environmentally friendly nano-sized fire retardant - organobentonite (OB).

To ensure uniform distribution of additives in the polymer matrix, polyethylene modified with maleic anhydride was used. The starting components were pre-mixed in a laboratory mixer, then the compositions were extruded on a Brabender extrusion unit. To improve the distribution of halogen-free additives in the polymer matrix, PE modified with maleinated groups (PE small) was introduced into the compositions at the extrusion stage. PE mal acted as a compatibilizer. Organobentonite was introduced in the form of a 10% superconcentrate based on LDPE 11503 – 070 and Sevilen 11306-075. Two matrices were used to study the uniformity of filler distribution. To improve the distribution of OB, polyethylene and sevilene modified with maleic anhydride were added to the masterbatches, respectively. The composition of the compositions is presented in Table 1.

Melt flow index (MFI) is an important technological indicator in the production of films by extrusion. In this regard, we studied the MFI of the resulting compositions. As can be seen from the proposed diagrams in Fig. 2 and 3, the MFI values are within the permissible values for film production; no sharp decreases or increases were observed.

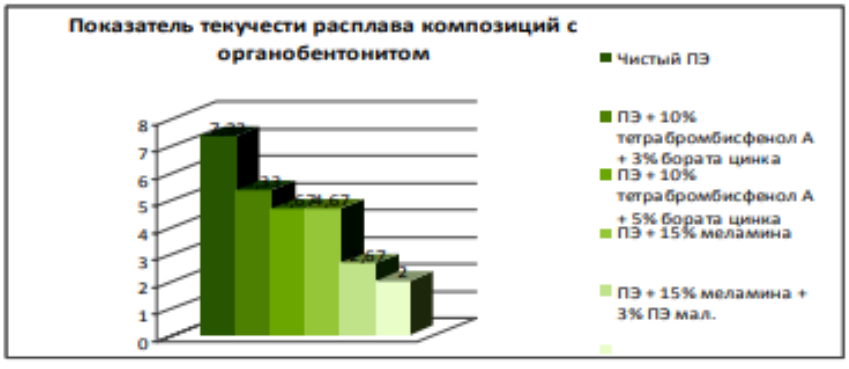

Fig.2. Diagram of MFR values depending on the OB content in the composition

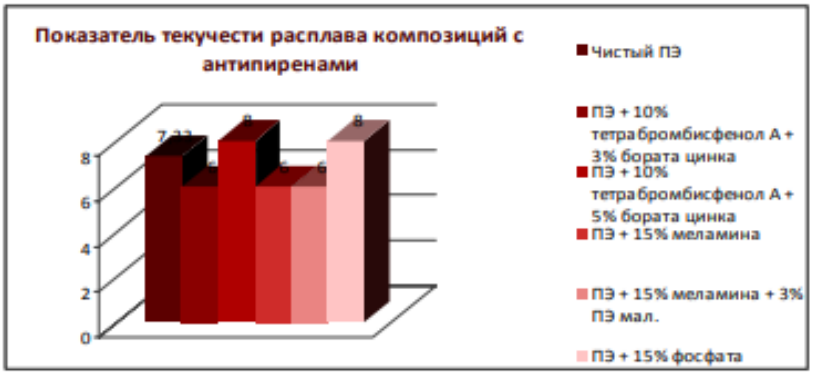

Fig.3. Diagram of MFI values depending on the content of flame retardants in the composition

The introduction of OB into the polymer matrix led to an increase in the physical and mechanical properties of the film. With the introduction of up to 1% OB, a significant increase in tensile strength in the longitudinal direction is observed, as illustrated in Fig. 4.

Fig.4. Dependence of tensile strength in the longitudinal direction on the OB content in the composition

Based on this dependence, we can assume the presence of a process 17 of OB intercalation in the polymer matrix. As a result of intercalation, the specific surface area of the filler increases, accordingly its effectiveness and the strength of the entire composition increases. Fire retardants, when introduced into a polymer matrix, behave as strengthening fillers. The highest value of the indicator is achieved in a composition containing 10% tetrabromobisphenol A and 5% zinc borate [2].

Practical significance of the work.

Methods for reducing the flammability of polymer materials are based on the following principles:

changing the thermal balance of the flame due to an increase in various types of heat loss;

reducing the heat flow from the flame to the polymer by creating protective layers, for example forming coke;

reducing the rate of polymer gasification;

changing the ratio of flammable and non-flammable decomposition products of the material in favor of non-flammable ones.

There are several ways to reduce the flammability of polymer materials, which can be divided into the following groups:

fire protection using flame-resistant materials (fire-retardant coatings);

introduction of combustion fillers or flame retardants;

modification of polymer materials.

Along with the first and second methods, polymer materials are impregnated with fire-extinguishing compounds capable of forming a protective layer on the surface of the material.

Fire protection with flame-resistant materials involves covering products made from combustible materials with tiles, sheets of non-combustible or non-combustible materials. Fire-retardant paints, varnishes, and foaming coatings can be used as fire-retardant coatings. The advantages of fire-retardant coatings are ease of manufacture and relatively low cost of work. The disadvantage of this method is that when the temperature rises, the fire retardant coating peels off from the main combustible material, which causes the main material to catch fire. For foam coatings, which, when exposed to fire or heat, produce a fast-growing, non-flammable, small, closed-cell foam, a decrease in adhesion of the coating to the material is less likely due to the dramatic reduction in heat transfer through the coating.

The introduction of fillers leads to a slight decrease in flammability; some flame retardants (red phosphorus, Sb_20_3, salts of phosphoric acid, etc.) can be considered as fillers in the case when their dissolution in the material is not observed. Glass fibers, asbestos, and carbon fibers are widely used as reinforcing materials, improving physical and mechanical characteristics, heat resistance and at the same time leading to a decrease in the flammability of polymers.

Oxides and hydroxides of some metals, graphite, antimony Sb_20_3, zinc borates $(Zn_3(B0_3)_2$, natural inorganic substances (kaolin, pumice, gypsum, perlite, montmorillonite, vermiculite) are used as powdered fillers that help reduce flammability. various salts such as oxalates and carbonates.

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