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Study of Properties of Polyvinyl Chloride Modified with Oligomeric Antipyrine

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Abstract: In this article, flame retardant polymer materials produced by modifying PVC polymers with oligomeric flame retardants based on local raw materials were processed to 110-160 °C, and it was determined in SEM analysis that bubbles and micropores were formed on the surface of the polymer. Fire resistance and environmental impact reduction properties of modified polymer materials have been revealed.

Keywords: Flame retardant compositions, oligomeric antipyrine, environmental effects, polyvinyl chloride (PVC), modifiers, electron microscopic and elemental analysis.

Polyvinyl chloride (PVC) is a widely used polymer in electrical and communication cables, coatings, and construction materials, and its production is increasing year by year. Due to the toxic substances contained in PVC, there are high requirements for use. One of the negative features is the release of various gas mixtures (chlorine compounds, benzene and other aromatic substances) from PVC-based building materials or electric cables due to heat and ignition [1; 2].

It is known that heavy metals are widely used in the stabilization of physical and mechanical properties of PVC. In order to determine whether these heavy metals have a significant impact on the environment and human health, scientific research has been conducted by scientists and it has been studied whether they are in the soil, water (rivers, lakes, underground water) or air, and have a bad effect on organisms in the affected environment, including human health [3; 4; 5].

Therefore, taking into account environmental problems, it is necessary to create environmentally friendly and sustainable compositions in the use of antipyrine to increase the fire resistance of PVC and other polymer materials. Due to the development of various laws for the production of environmentally friendly antipyrine in the world, the use of antipyrine, which have been proven to cause serious damage to the environment, has decreased sharply, and the need for environmentally friendly flame retardants is increasing [6; 7].

In fact, PVC is a polymer with high heat and fire resistance, due to this feature, chlorine and other harmful gases are released from its composition under the influence of heat. In order to solve these problems, some disadvantages have been eliminated as a result of adding plasticizers and stabilizers to PVC. But since its fire resistance does not meet the standard requirements, antipyrine containing boron, aluminum, phosphorus, antimony, chlorine and bromine are widely used today to increase the fire resistance of PVC. The use of these chemical elements in polymers has been found to significantly affect thermal, mechanical and electrical properties [8; 9]. Various metal-containing chemical compounds, coordination compounds, and different proportions of inorganic and organic compounds make it possible to create antipyrine with stable properties for PVC.

In this article, oligomeric antipyrine containing phosphorus, nitrogen, silicon and metal in different proportions were obtained and modified with them, the composition and distribution of impurities on the polymer surface was studied using a scanning electron microscope and elemental analysis. The main novelty of this research is not only a comprehensive review of the modification of oligomeric antipyrine containing phosphorus, nitrogen, silicon and metal with polymers in different proportions, but also the study of synergistic effects, properties of chemical additives that have a great effect on increasing fire resistance.

By studying the results of electron microscopic and elemental analysis of antipyrine polymer materials obtained as a result of modification of PVC with oligomeric antipyrine containing phosphorus, nitrogen, silicon and metal, it was studied the spread of antipyrine in PVC, synergistic effects and increase of fire resistance. The fire resistance of the materials is increased by adding 5-30% of PVC-K, PVC-A, PVC-F, PVC-KP, PVC-B and PVC-M oligomeric antipyrine based on phosphorus-containing compounds to the composition of PVC polymer materials, and these polymers are scanned It was possible to determine the distribution of polymer on the surface of composite materials using electron microscope and elemental analysis.

In these test experiments, the surface of the samples was coated with gold powder to a thickness of 5 nm using a special method using a QUORUM Q150 RS device. Analyzes of the results obtained on the distribution of oligomeric antipyrine on the PVC surface of the 6 proposed samples (PVC-K, PVC-A, PVC-F, PVC-KP, PVC-B and PVC-M brands) were

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considered separately. By modifying PVC polymers with PVC-K brand oligomeric antipyrine, the morphological structure of the particles was studied, whether they were uniformly distributed on their surface and did not settle.

Based on the research, the heat effect of mixtures formed by modifying PVC polymers with different amounts of PVC-K brand oligomeric antipyrine was studied. It is known from research and literature that the release of chlorine in PVC as a result of exposure to heat has been studied. PVC modified with these antipyrine in different proportions (10%, 15% and 20%) was treated up to a temperature of 160 °C and it was determined in SEM analysis that bubbles and micropores were formed on the surface of the polymer. The addition of PVC-K brand oligomeric antipyrine and mixtures formed by modifying PVC polymers in different amounts has a synergistic effect, which means that substances are uniformly distributed on the surface of the polymer material. As the amount of PVC-K brand oligomeric antipyrine increases, we can see that the release of chlorine gases in PVC due to temperature decreased, and the formation of bubbles and micropores decreased in pictures B, C, D. Figure A shows that plasticized PVC was exposed to a temperature of 160oC and its white color was formed by the effect of PVC and plasticizers in SEM analysis. In this image, the formation of bubbles and micropores was found to be high.

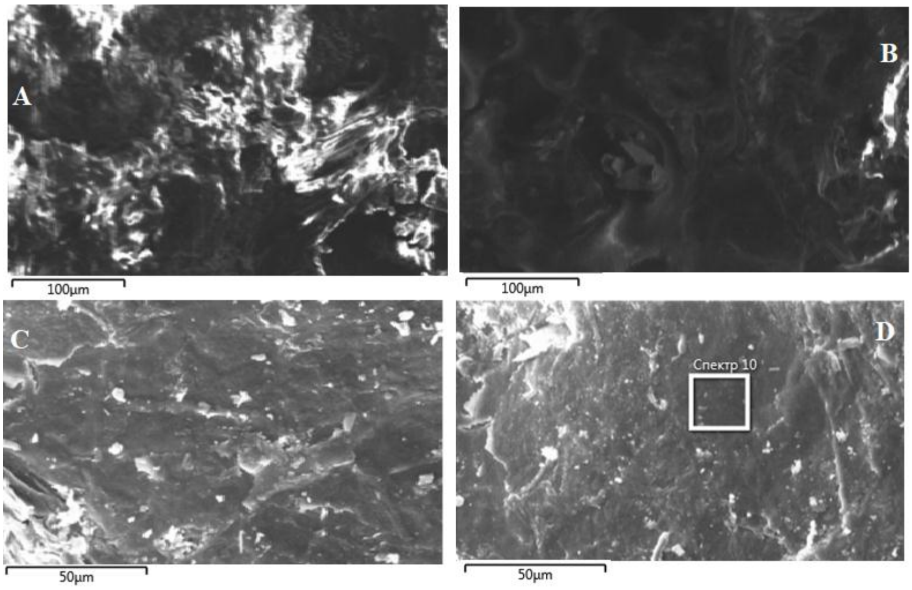

Figure 1. SEM analysis of PVC blends modified with PVC-K brand oligomeric flame retardants in different proportions (10%, 15% and 20%).

As can be seen from Figure 2, if we pay attention to the electron-microscope analysis of the processed PVC, it is possible to determine the presence of a uniform layer between the polymer, and this layer ensures the improvement of the mechanical properties of the material.

An elemental analysis was carried out in order to find out what elements are present on the surface of PVC modified with PVC-K brand oligomeric antipyrine. Elemental analysis reveals the carbon, oxygen, and silicon, phosphorus, sulfur, and metals associated with the polymer as antipyrine.

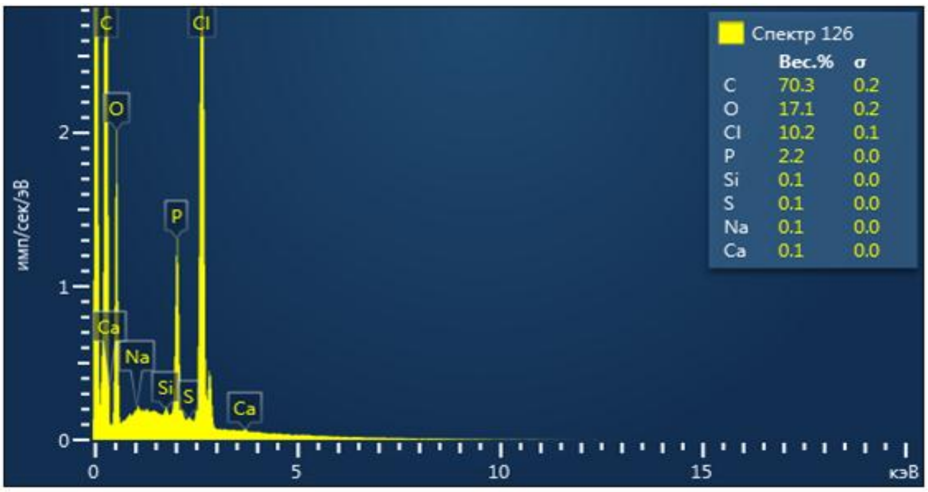

Figure 3.4. Elemental analysis of PVC modified with PVC-K oligomeric antipyrine.

Thus, fire retardants obtained on the basis of local raw materials reveal properties of modified polymer materials to increase their fire resistance and reduce their impact on the environment. The widespread use of fire-resistant PVC-based polymer materials in the energy and construction sectors, as well as in various manufacturing enterprises, leads to environmental and economic efficiency.

The heat effect of mixtures formed by modifying PVC polymers in different amounts with PVC-A brand oligomeric antipyrine was studied. PVC modified with these antipyrine in different proportions (10%, 15% and 20%) was treated up to a temperature of 160 °C and it was determined in SEM analysis that bubbles and micropores were formed on the surface of the polymer. The addition of PVC-A brand oligomeric antipyrine and mixtures created by modifying PVC polymers in different amounts has a synergistic effect, which means that substances are uniformly distributed on the surface of the polymer material. With the increase in the amount of PVC-A brand oligomer antipyrine, we can note that the release of chlorine gases in PVC due to the influence of temperature has decreased, that is, the formation of bubbles and micropores has decreased. In this image, the formation of bubbles and micropores was found to be high.

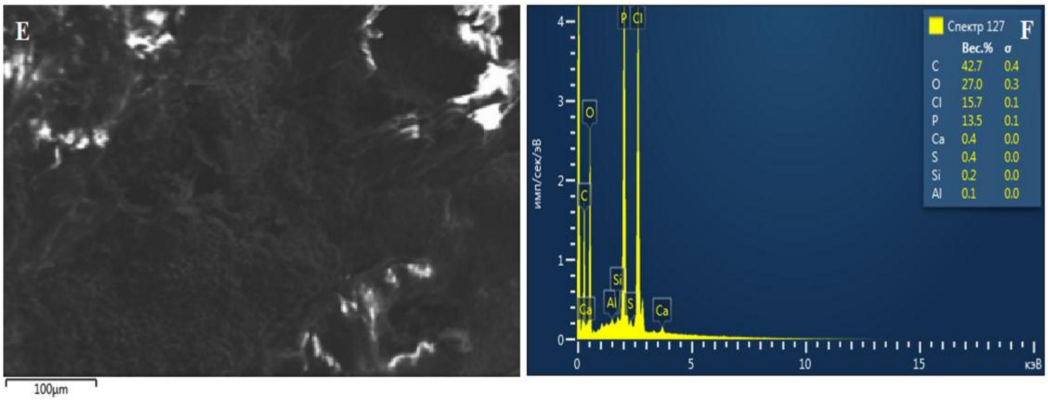

Figure 3. PVC mixtures modified with PVC-K brand oligomeric antipyrine in different proportions (20%)SEM (E) and (F) element analysis analysis.

In the scanning electron microscope analysis presented in Figure 3, it can be understood that composite compounds were formed together with antipyrine polymer materials. Synergistic properties of compounds containing phosphorus, nitrogen, metal oxide, boron and silicon are uniformly distributed on the surface of the polymer.

It can be clearly seen from the pictures that the oligomeric antipyrine that make up the PVC-F and PVC-KP brands were uniformly covered by the composites made by PVC-based polymer materials as shown in Figure 4. PVC modified with these antipyrine in different proportions (10%, 15% and 20%) was treated to a temperature of 110-160 °C and it was found in SEM analysis that bubbles and micropores were formed on the surface of the polymer. With the increase in the amount of oligomeric antipyrine based on PVC-F and PVC-KP brands, it can be noted that the release of chlorine gases in PVC under the influence of temperature has decreased, that is, the formation of bubbles and micropores has decreased. This scanning electron microscope analysis revealed that a thick polymer coating was formed on the surface of the composite. An elemental analysis was carried out in order to determine the mixture of elements on the surface of PVC polymer materials modified with PVC-F and PVC-KP fire retardants. Elemental analysis shows carbon, oxygen, chlorine, and nitrogen, phosphorus, and metals related to the polymer in antipyrine.

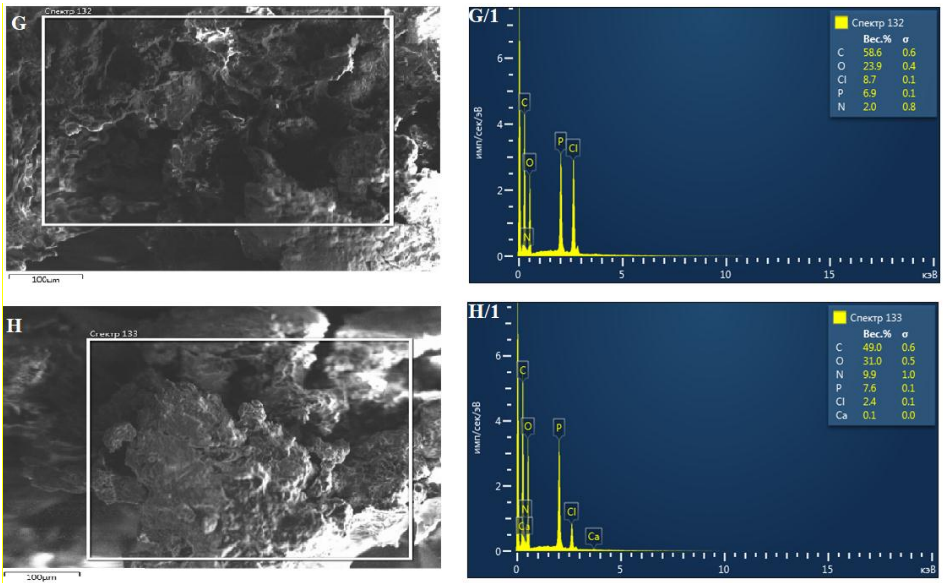

Figure 4. SEM and elemental analysis of PVC mixtures modified with oligomeric antipyrine based on PVC-F (G: G/1) and PVC-KP (H: H/1) brands in different proportions (20%).

It is possible to clearly see the location of the particles in the composites that formed the PVC-B and PVC-M brands of oligomeric antipyrine and PVC-based polymer materials (Fig. 5). PVC modified with these antipyrine in different proportions (10%, 15% and 20%) was treated to a temperature of 110-160 °C and it was found in SEM analysis that bubbles and micropores were formed on the surface of the polymer. With the increase in the amount of oligomeric antipyrine based on PVC-B and PVC-M brands, we can note that the release of chlorine gases in PVC under the influence of temperature has decreased, that is, the formation of bubbles and micropores has decreased. PVC-B and PVC-M based antipyrine, an elemental analysis was carried out in order to determine the composition of elements on the surface of PVC polymer materials modified with antipyrine. Elemental analysis shows carbon, oxygen, chlorine, and nitrogen, phosphorus, and metals related to the polymer in antipyrine.

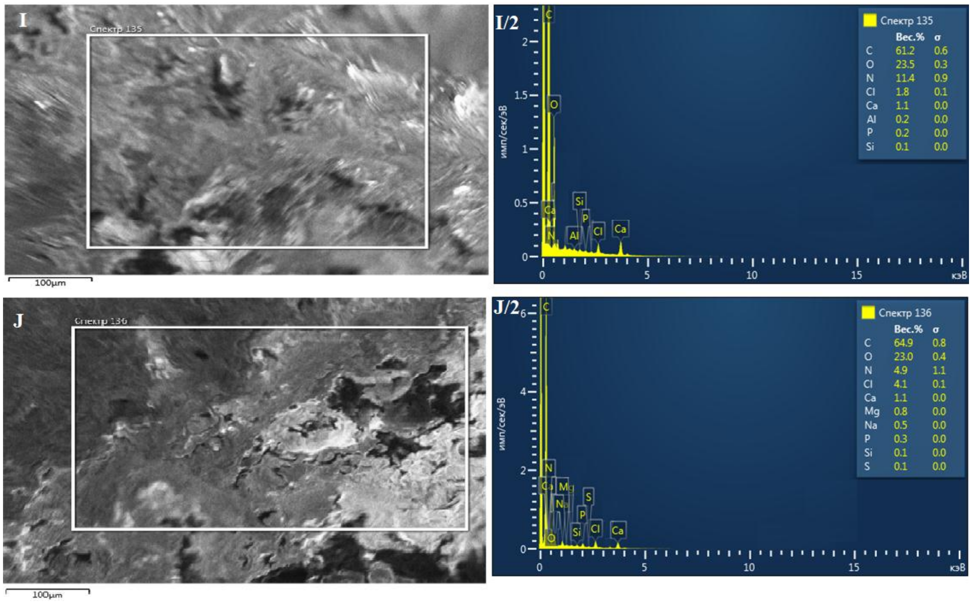

Figure 5. SEM and element analysis analysis of PVC mixtures modified with oligomeric antipyrine based on PVC-B (I: I/1) and PVC-M (J: J/1) brands in different proportions (20%)

From the SEM analysis of the composites formed by new types of PVC-K, PVC-A, PVC-F, PVC-KP, PVC-B and PVC-M brand oligomeric antipyrine with PVC polymer materials, it can be seen that they are uniformly distributed on the surface of the polymer samples treated with antipyrine. When processing polymers with new types of environmentally friendly antipyrine, it was found that the properties and fire resistance properties of PVC-based polymers are improved.

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