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CHEMICAL FIBRES FOR MODIFICATION OF TEXTILE MATERIALS BASED ON FIRE RETARDANT SUSPENSIONS

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ABSTRACT: The article presents the results of physical and mechanical characteristics of cellulose materials, the composition of element-containing fire retardant compositions for modifying cellulose materials, during wet processing of samples of modified textile material based on cellulose with a fire retardant, it is possible to judge by the change in the mass of samples. Moreover, short-term heat fixation, especially under some pressure, contributes to the simple fixation of the mixture on the material. They show the absence of strong chemical bonds in the samples obtained during short-term processing of the vermiculite mineral to obtain a fire retardant suspension for materials to impart thermal and fire-protective properties.

Key words: physical and mechanical characteristics, cellulose material, fire retardant suspension, orthophosphoric acid, heat and fire resistance.

АННОТАЦИЯ. В статье приведены результаты физико-механические характеристики целлюлозных материала, Состав элементсодержащих антипиреновых композиций для модификации целлюлозных материалов, при мокрой обработке образцов модифицированного текстильного материала на основе целлюлозы антипиреном можно судить по изменению массы образцов. Причем, простому закреплению смеси на материале способствует кратковременная термофиксация, особенно под некоторым давлением. Показывают отсутствие сильных химических связей в образцах, полученных при кратковременных обработках минерала вермикулита для получения суспензии антипирена для материалам чтобы придать термо- и огнезащитные свойства.

Ключевые слова: физико-механические характеристики, целлюлозный материал, антипиреновая суспензия, ортофосфорная кислота, термо- и огнестойкость.

Currently, a method of fire-retardant impregnation [1] has been implemented on an industrial scale, based on the use of orthophosphoric acid and nitrogen-containing compounds (dicyandiamide, urea, melamine, guanidine, etc.). According to this method, the fabric is treated with a composition including phosphoric acid and one of the listed nitrogen-containing compounds, and subjected to heat treatment, as a result of which tricyanurea and metaphosphoric acid interact to form a poorly soluble salt. For this type of treatment, it is proposed to use a large number of polyfunctional or unsaturated compounds containing phosphorus, halogen and nitrogen. A significant disadvantage of this method of treatment is a noticeable decrease in the resistance of the fabric to tearing load (the decrease in tear strength is 50-60%) [2-4].

Based on the analysis of literature on fire-retardant treatment of fabrics, several compounds can be identified that have received the widest distribution. These compounds can form cross-linked polymers on the surface of the material in the presence of amines or amides and

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simultaneously interact with the hydroxyl groups of cellulose to form cross-linked structures. The most difficult to fire-protect is a mixture of cotton and polyester fiber, since during combustion of such mixed fabrics, a lighter change in the mass of the sample and a more noticeable decrease in the amount of coke residue is observed than in fabrics consisting only of cotton. To obtain fire-retardant fabrics from a mixture of polyester and cellulose fibers, compositions containing phosphorus, nitrogen-containing and a cross-linking reagent are used [5]. The treatment is carried out according to a regime that includes impregnation with an aqueous solution of glycasin, drying, impregnation with an aqueous solution of fire retardant followed by drying, heat treatment and washing. The fabrics obtained from a mixture of polyester and cellulose fibers (in a ratio of 67:33%) were characterized by an oxygen index of 28-30% with a fire retardant content of no more than 10-12%. As studies have shown, the high efficiency of the fire retardant fire protection is explained by the inhibition of processes occurring both in the condensed and gas phases of thermolysis and combustion. Quite a lot of attention is currently paid to the study of the structure and properties of polyethylene terephthalate and fibers based on it. The flammability of polyester fibers is reduced by using reactive fire retardants that can become insoluble. For fire protection of polyester fibers, a class of halogen-containing organic compounds is used, halogen-phenyl and polyhalogen-phenyl terephthalates, bromine-containing phosphate and phosphite, the heat-resistant properties of which depend on their linear structure [6-8].

Analysis of works on the study of the mechanism of action for cotton and polyester materials showed that some of the most effective and universal in terms of fire protection are phosphorus-containing organic compounds. Issues of fire protection of fabrics from a mixture of polyester+cotton, polyester+viscose fibers with different quantitative ratios of components require further research [9-10].

It should be noted that not only the treatment of textile fibers and materials with fire retardants leads to an increase in the fire resistance of the final products, but the development of accessible and new methods for synthesizing the initial products to obtain fibers and subsequently materials on their basis to a certain extent regulates the formation of polymer macromolecules in the process of their synthesis.

As a result, it is possible to obtain stereoregular polymers with heat resistance, which contributes to increasing the fire resistance of the final materials. Taking into account the above, we consider it necessary to provide in this monograph a description of the processes for obtaining fiber-forming polyacrylonitrile by the method of complex-radical polymerization and to show the advantages of the method we have developed, which allows obtaining heat-resistant polyacrylonitrile due to intra-macromolecular cyclization.

For the research, textile materials of different functional purposes were selected, representing fabrics [8]. The main characteristics are presented in Table 1.

The development of a technology for combining the process of fire-resistant finishing of various polymers with polymer fire retardants in order to improve fire protection, thermal and other applied properties is a very pressing problem and affects many areas of modern chemistry and technology for the production of natural and synthetic fibers.

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The theoretical foundations of combining stages of imparting fire resistance to natural and synthetic fibers were studied. To achieve the set goal, it was necessary to study the properties of fibers treated with fire-resistant materials; mutual influence, i.e. compatibility of fire-resistant preparations; to study the influence of mechanical effects on the physical and mechanical properties of textile materials based on natural and synthetic fibers.

Table 1

Fabric composition	Surface density, g/m^{-2}	Number of threads		Weight of one bundle of threads (50) pcs, mg		Linear thread density tex		The nature of threads	Interweaving of threads
		Warp	Duck	Warp	Duck	Warp	Duck		
Natural fiber cotton	184	214	148	254	244	44	46	Single thread	Linen
Synthetic fiber	162	3104	174	134	65	28	15	Single thread	Twill

Physical and mechanical characteristics of textile material

In order to increase the fire resistance of textile materials based on cellulose, their surface was impregnated with acrylic emulsion and methacrylates in combination with glycerin. The samples were treated both directly with glycerin, with subsequent impregnation of the composition, and in a mixture with hetero-containing substances. The compositions of the developed polymer composition based on element-containing compounds for modifying cellulose material are presented in Table 2.

Table 2

Composition of element-containing fire retardant compositions

for modification of cellulose materials

№	Compound				
	Material weight, g	Emulsion, g	Element-containing mixture of acid and alkali, g	Glycerin, g	Initiator, g
1	2,0	0,2	0,5	0,2	0,001
2	2,0	0,3	0,6	0,3	0,001

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3	2,0	0,4	0,7	0,4	0,001
4	2,0	0,5	0,8	0,5	0,001

The modified cellulose material was processed using the following methods:

- impregnation with a solution of element-containing acid for 1 hour at 298 K, drying at room temperature, treatment in an initiator solution (2 hours), drying, holding for 4 hours at a temperature of 333 K in a glycerol solution. The dried samples were heat-fixed at a temperature of 398 K for 5 minutes; - impregnation in a solution of a mixture of an element-containing mixture and acrylic acid for 4 hours at a temperature of 600C, followed by drying and heat-fixation.

During the thermal action, the element-containing acid undergoes esterification with the functionally active groups of cellulose. On the other hand, polyacrylate forms a strong film of the element-containing mixture filled with molecules on the surface of the material. When wet processing samples of modified cellulose-based textile material with a fire retardant, one can judge by the change in the mass of the samples. Moreover, short-term thermal fixation, especially under some pressure, facilitates simple fixation of the mixture on the material. Thus, the developed fire retardant compositions based on element-containing compounds can be used to modify textile materials based on cellulose material in order to impart flame retardancy to them; treatment with fire retardant compounds does not reduce the physical, mechanical and hygienic properties of textile materials; in some cases, they are improved. High physical and mechanical strength is retained after thermal action on the textile material.

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