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RESEARCH OF FIRE RESISTANCE OF TEXTILE FABRICS BASED ON CELLULOSE

Abstract: *The article examined the optimal temperature for the synthesis of an eco-friendly fire retardant, product shelf life, physicochemical and mechanical properties, elemental analysis of textile fabrics containing a new type of metal, and fire-resistant properties. In addition, flammable textile materials have been shown to have high heat, and fire resistance properties, and their mass loss has been found to decrease from 97.3% to 21.3%.*

Key words: *cotton industry, flame retardant, metal, environmentally friendly flame retardant, physicochemical properties, element analysis, oligomer, urea adduct, fire resistance, processed fabric.*

Language: *English*

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Introduction

At the present time, ec-friendly fire protection products are widely used all over the world. The composition of the compositions included in such fire retardants is varied and includes different ingredients. Such flame retardants are used to protect wood, metal, various cables and textile materials from fire [1; 2].

Cotton is consider the main raw material of the textile industry, and it is widely used in the world as an industrial crop [3; 4]. Although many new fabrics are available today, cotton fabrics are still widely used today owing to their superior properties and benefits due to the following: good moisture absorption and high breathability, soft and comfortable to wear; have excellent thermal insulation; cheap cost, because they are made from natural plants [5; 6]. These advantages simplify the use of the cotton fabric in various textiles such as underwear and children's clothing, in skin-friendly clothing [7; 8]. However, as raw material cotton fabrics can cause serious harm to people because they are flammable materials, which are why many countries have enacted strict laws, and regulations regarding the fire resistance of cotton fabrics. Numerous studies have been carried out to improve the fire resistance of cotton fabrics [9; 10]. Halogen flame retardants are effective and widely used, but research has shown that halogen flame retardants have good fire-fighting properties, but can cause serious environmental problems, including large amounts of smoke, in the event of a fire, including the production of toxic gases. For this reason, the use of halogens in effective fire protection

products is currently decreasing [11; 12]. However, textile materials have treated with this category of fire retardants do not have sufficient flexibility and a high degree of rigidity, which complicates the production of special clothing [12].

Experimental part

The safety and fire resistance of cellulose-based textile fabrics is an urgent problem. The research resulted in a new type of environmentally friendly flame retardant containing nitrogen and phosphorus to improve the fire resistance of textile materials. A fire retardant containing metal in the synthesized composition was obtained at a temperature of 170-180° C with a yield of 92%. The physicochemical properties and elemental analysis of metal-containing organic oligomers have been studied.

Experimental tests for fire resistance of the developed composition were carried out in accordance with GOST R 50810-95, which determines the method for determining the flammability, constant fire resistance of textile materials, as well.

Results and its discussion

In the studies, a fire retardant on the basis of the phosphorus, nitrogen and a metal-containing oligomeric composition, Which the named after TEH-1 brand 20% plus solution containing a basic substance, a metal-containing adduct urea, a crosslinking agent based on urotropine, and ammonia were used for neutralization. To increase the wettability of the treated fabric, surfactants were used.

The physical and chemical properties of an environmentally friendly flame retardant containing nitrogen and phosphorus of a new type are shown in Table 1 below.

Table 1. Physicochemical properties of an environmentally friendly fire retardant containing nitrogen and phosphorus new.

	State of aggregation	pH	Density g/sm^3 г/см^3	Solvent
Environmentally friendly flame retardant containing nitrogen and phosphorus of a new type.	Powder of white	5,5	1,08	Dissolve 10% in a water at 80 ^{o}C.

The IR spectrum of these oligomer flame retardants shows that there are absorption lines belonging to the -CH_2 - group corresponding to valence oscillations in the 2850 cm-1 region of the organic matter absorption line, while the absorption lines in the 1340cm-1 area belong to the carbon and hydrogen holding groups. The oscillations of all active groups are manifested in the form of strong narrow lines –CH_2–CO-in the range of 1465 - 1380 cm-1. The IR spectrum confirms the presence of absorption in the 1460-1300cm-1 C=S groups and regions 450-550cm-1, and confirms the presence of C-C groups, and that phosphorus bonds containing organic compounds can be observed in the 1300-1200cm-1 and 1180-1040cm-1 regions. P=O and P-O-C groups. The absorption lines in the 1650 cm-1 region of the IR spectra indicate the presence of free –$CONH_2$ groups, and the absorption lines in the 3300-3440 cm-1 region indicate the presence of secondary–CONH groups.

Assimilation ranges between 800 and 1600 cm-1 confirm the presence of NH_2 groups. In addition, intensities occur in the IR spectrum involving the bonding of metal-containing compounds between 600–800cm-1 and 1460cm-1.

The surface of a textile fabric treated with a new type of flame retardant was visualized under a scanning microscope and the element was analyzed (Fig. 1).

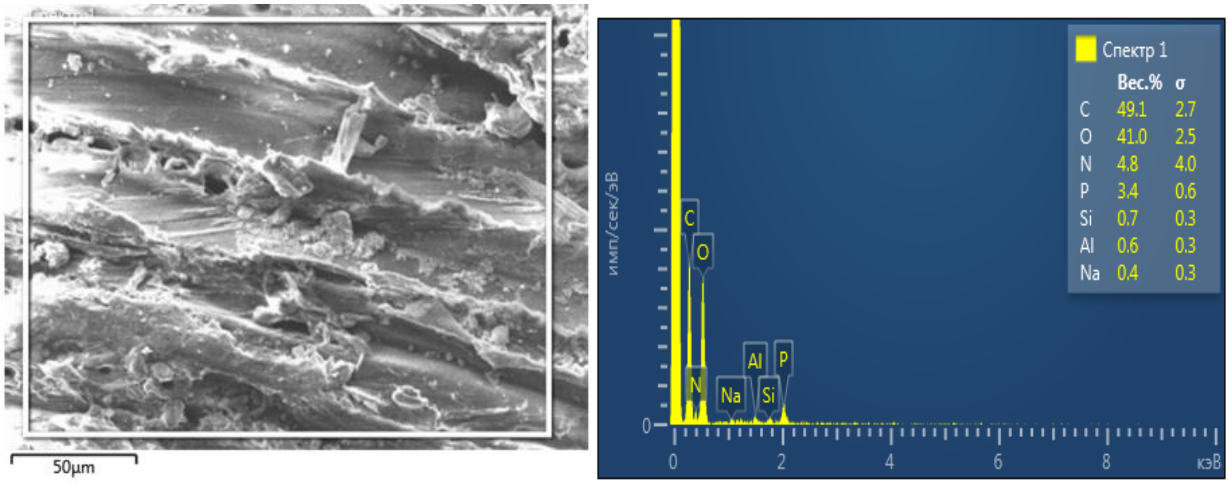


Fig-1. Image of the surface of a fabric treated with a flame retardant

Elemental analysis was performed to determine which elements are present on the surface of the new type of flame retardant textile. When studying the analysis of an element, nitrogen, phosphorus, metals in carbon, oxygen and the content of fire retardant in cellulose can be seen (Table 2).

Table 2. Result of the elements analysis

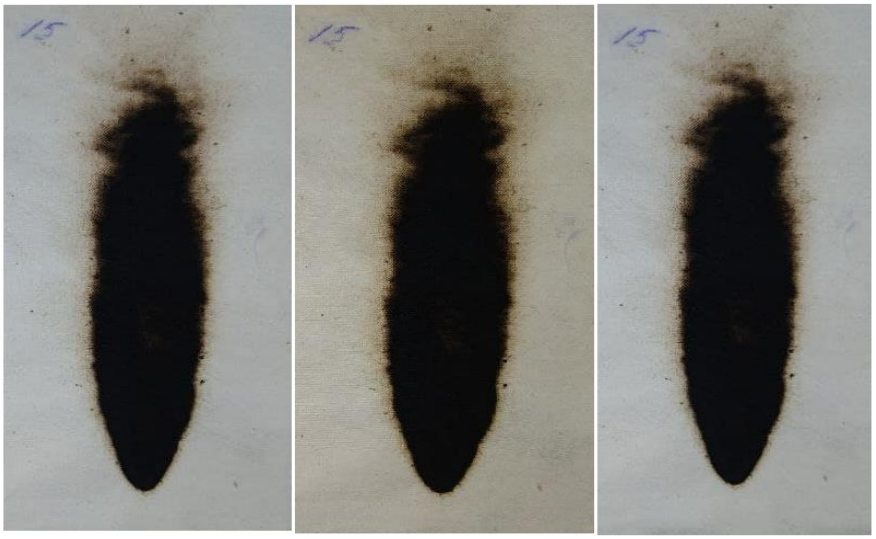
Element	Weight .%	Sigma Weight.%
C	49.08	2.73
N	4.83	4.01
O	4101	2.49
Na	0.41	0.28
Al	0.57	0.29
Si	0.71	0.29
P	3.40	0.57

Experimental tests for fire resistance of the developed composition has been carried out in accordance with GOST. Experiments on the fire resistance, and physical also mechanical properties of cellulose-on the basis of the textile materials treated with a TEX-1 flame retardant has been carried out. (Table 1)

Table 3. Experimental results and physical and mechanical indicators of tests for fire efficiency (TECH-1)

concentration of fire retardant, g/l	The length of the charred area, mm			Breaking load, N		
	Heat treatment, ºC					
	110	130	150	110	130	150
Sample of the initial	220	220	220	202	202	202
TEX-1 brand; 150 g/l	124	136	132	199	200	199
TEX-1 brand;300 g/l	115	122	118	198	199	198
TEX-1 brand; 400g/l	112	113	110	197	198	198

These are experimental testing processes (Figure 1). apply to all flammable textile materials supplied to the consumer to improve their fire resistance and conduct test experiments in accordance with the standards. The samples were also tested for changes in mechanical properties after processing.



Picture 1. Condition of cellulose-based fire retardant materials after exposure to fire.

The results of the study of the efficiency of using the recommended compositions showed that the length of the coal section decreases with an increase in the concentration of the compositions. Since the absorption of flame retardant chemicals into textiles was relatively difficult, the tensile strength did not change much. Thus, it can be seen that the mechanical properties of the flame retardant fiber are close to each other in all proportions. However, due to the addition of epichlorohydrin to the TEX-1 brand oligomer, it was found that the mechanical and fire retardant properties were higher compared to analogues and others when treated with this fire retardant and heated to 110-150 ° C. Studies have shown that when the antiroll is increased and the average heat treatment temperature is 130-150 ° C, the flammability of the fiber increases as the binding rate increases as a result of the interaction of the composition with the hydroxyl groups of cellulose in the fiber. However, the big difference from analogs is that composites combined in this way are difficult to wash off with water. The main difference from our offered fire-resistant counterparts is that they are more effective at relatively low doses.

In the next stage of the experimental test processes, the formation of coke and mass loss of flammable textile materials treated with TEX-1 brand oligomeric flame retardants were studied. The mechanism of action of fire-fighting chemical compounds is that the release of nitrogen, phosphorus, carbon, and water vapor as a result of the synergistic effect of flame retardants in textile materials prevented combustion by disrupting the oxygen supply if the fire did not reach the desired temperature.

TEX-1 branded oligomeric flame retardants based on local raw materials were processed into textile materials to increase their flammability, and test results showed that their coke formation increased after treatment with different concentrations of flame retardants. This coking process was carried out in experimental experiments on flammable textile materials, and as a result, a mass loss of 58.8-21.3% was studied for textile materials. Test results of environmentally safe flammable oligomeric flame retardants for the production of textile materials have been studied and these results are presented in Table 4.

Table 4. Investigation of coking properties of composites processed into textile materials (TM) with flame retardants

№ Sample		Weight of the up to test,gr	Burning time, sek	Sample, %	Weight of the after test,gr	Loss of weight	
						гр	%
TM		2,43	15	0	0,066	2,364	97,3
TEX-1	1	2,54	15	5	0,058	0,096	58,8
	2	2,58	15	10	2,50	0,078	30,5
	3	2,56	15	15	1,89	0,067	26,2

Thus, the following data were obtained by analyzing the test results of environmentally safe oligomeric flame retardants for the production of highly flammable textile materials required for our hot climate republic. According to him, the structure and physicochemical properties of oligomeric flame retardants were analyzed. In addition, flammable textile materials have been shown to have high heat and fire resistance properties, and their mass loss has been found to decrease from 97.3% to 21.3%.

By modifying textile materials on the basis of the oligomeric flame retardants, their widespread use as special clothing for firefighters, oil and gas industry, welders, metallurgists and workers of various manufacturing enterprises can lead to environmental and economic efficiency.

Conclusion

From the obtained SEM images, it can be seen that the flame retardant molecules are evenly distributed on the surface of the tissue samples treated with the flame retardant solution. At the same time, samples of fabrics treated with a fire retardant at various temperatures of 110oC, 130oC and 150oC were tested and found to meet the requirements of GOST. In addition, flammable textile materials have been shown to have high heat and fire resistance properties, and their mass loss has been found to decrease from 97.3% to 21.3%. When the fabric is treated with a new type of environmentally friendly fire retardant solution, improvements in fabric properties and flame retardant properties were found.

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