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Research Of Fire And Heat Protective Properties Of New Compositions For Building Structures And Materials

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Abstract – The main components of these coatings from local material raw materials were used soda liquid glass, kaolin silicon dioxide and the mineral wollastonite. During the experiments, the goal was to increase the heating time of samples of building materials to critical temperatures and analyze the results of such heating in the form of appropriate graphs and tables. The tests of protective compositions and the study of their heat-shielding properties made it possible to draw the following conclusions: due to the effective heat-resistant coating of the new compound, it is able to increase the flammability of the metal from a critical temperature of 500°C to 1200–1600°C, which lengthens the fire resistance of the metal over time.

Keywords – Heat-Resistant Coating, Metal, Warm-Up Time, Experiment, Sodium Liquid Glass, Silicon Dioxide, Kaolin Dioxide, Wollastonite, Apparatus For Determining The Heat-Insulating Properties Of Coatings.

Studies of the fire and heat protection properties of the developed building compositions and coatings based on them during the experiment showed that a significant increase in the fire and heat resistance of building materials and structures can only be achieved if such effective fire and heat protection coatings are used.

The task of fire and heat protection is to increase the heating time of the building material to critical temperatures. We have studied the fire and heat protection properties of new coatings developed for building materials based on local raw materials, such as cement, sodium carboxymethyl cellulose, glass sand, microsilica, porous component, finely dispersed wollastonite and basalt fiber.

At the first stage of research, new compositions and coatings based on them for metal products were synthesized and their heat-shielding properties were studied. experiments, which are given below in the form of tables and graphs.

In recent years, construction work in our country is in full swing. This, in turn, requires that their safety, including fire safety, become one of the urgent tasks. The results of the analysis of fires show that one of the most pressing issues in ensuring fire safety of buildings and structures today is to further improve the basic measures aimed at protecting buildings from fire, increasing their fire resistance. These measures are primarily aimed at reducing the fire risk of structures and increasing their fire resistance at the required level.

The main tasks of fire resistance include: its prevention in the immediate initial stage of the fire; creating a passive mode of fire; reducing fire hazards and expanding opportunities in the selection of project solutions. The increase in the number of fires in modern buildings indicates the need for special fire safety measures.

Reducing the flammability of materials can be done in a variety of ways. These are achieved by painting the surface with special mixtures, varnishing, spraying and soaking under deep pressure, adding fire retardants to the starting composition, as well as by soaking materials on surfaces and deep with special systems using various technological approaches. The following methods can be applied to plywood, wood and plastic materials: joining (gluing) fire-resistant materials in different ways; bonding the soaked layered coatings together; painting plywood with special paints; coating with non-combustible materials, asbestos and metals, etc. Fire protection coatings based on organic polymers are also widely used in construction. Coatings such as Proterm steel, Uniterm, Fireflex, Ograx, Atlant, Joker, Unikum, which are widely used in the country, provide the flammability of metal structures from 30 to 90 minutes [1].

Typically, the effective protection periods of fire protection coatings will be specified in their specifications, and this period will be several decades. Over time, these coatings lose their properties GOST 9.40191 Unified system of protection against corrosion and aging. Paint and varnish coatings. General requirements and methods of accelerated testing for resistance to climatic factors is carried out according to the standard [2]. This standard does not take into account certain circumstances, such as the composition of the base on which the coating is applied or the conditions under which the coating is used. In view of the above, it is clear that one of the most pressing issues is to determine the shelf life of fire protection coatings based on organic polymers.

Fig. 1. Photographs of the obtained coatings on metal surfaces before and after testing.

Various samples of the obtained coatings on metal surfaces were tested to determine the value of thermal conductivity. The results of measuring the thermal conductivity of fire and heat-protective coatings obtained on various bases are shown in tables 1. and 2.

Table 1. Indicators for measuring the surface temperature of metal with and without coating

№	**Uncoated metal surface temperature index**		**Coated metal surface temperature index**	
Time (min)	$T_{in.}$ (ºC)	$T_{out.}$ (ºC)	$T_{in.}$ (ºC)	$T_{out.}$ (ºC)
1.	55	32	39	33
2.	130	54	156	41
3.	207	83	251	54
4.	252	113	313	67
5.	283	141	350	83
6.	302	164	370	97
7.	317	185	387	108

8.	330	195	394	120
9.	334	210	403	128
10.	342	217	404	135
11.	345	223	405	141
12.	350	228	408	145
13.	350	229	411	150
14.	354	234	411	154
15.	355	237	411	155

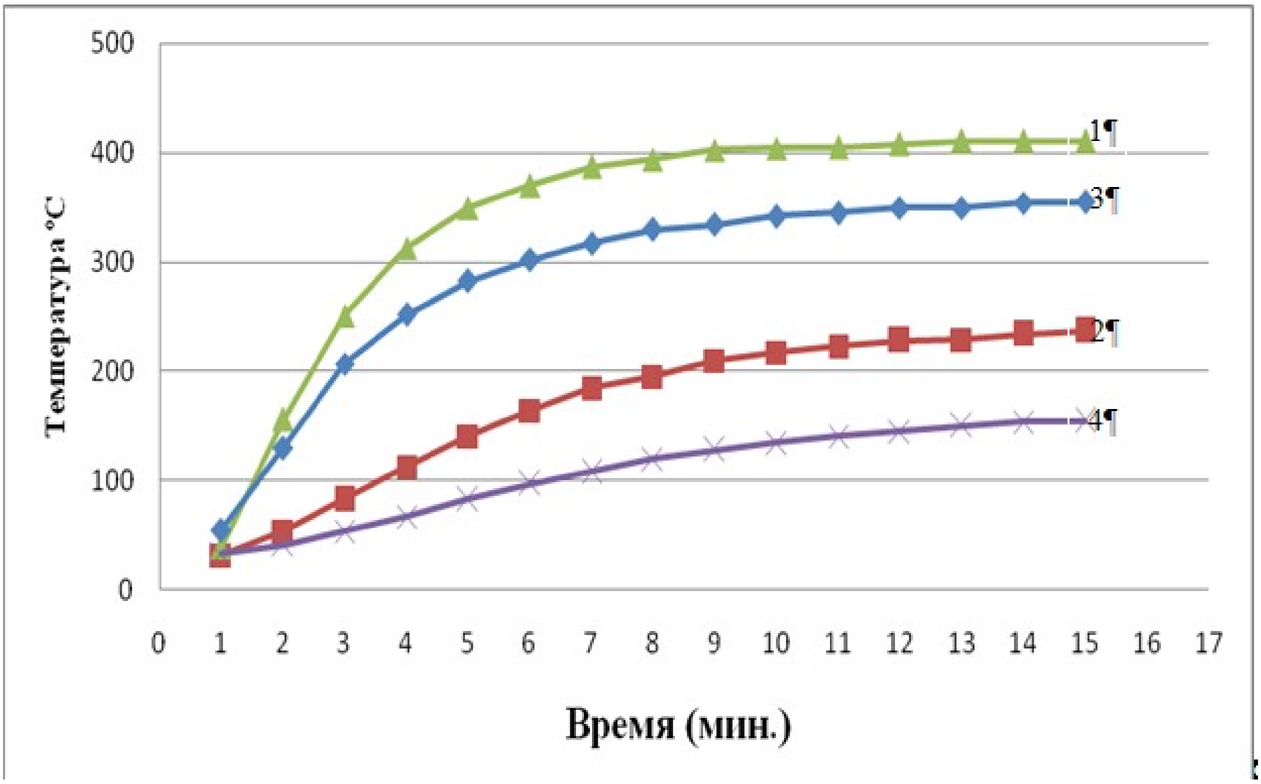

Fig. 2. Graph of the image of the thermal conductivity of the composition based on cement, hydrophobic thermovermiculite and finely dispersed wollastonite.

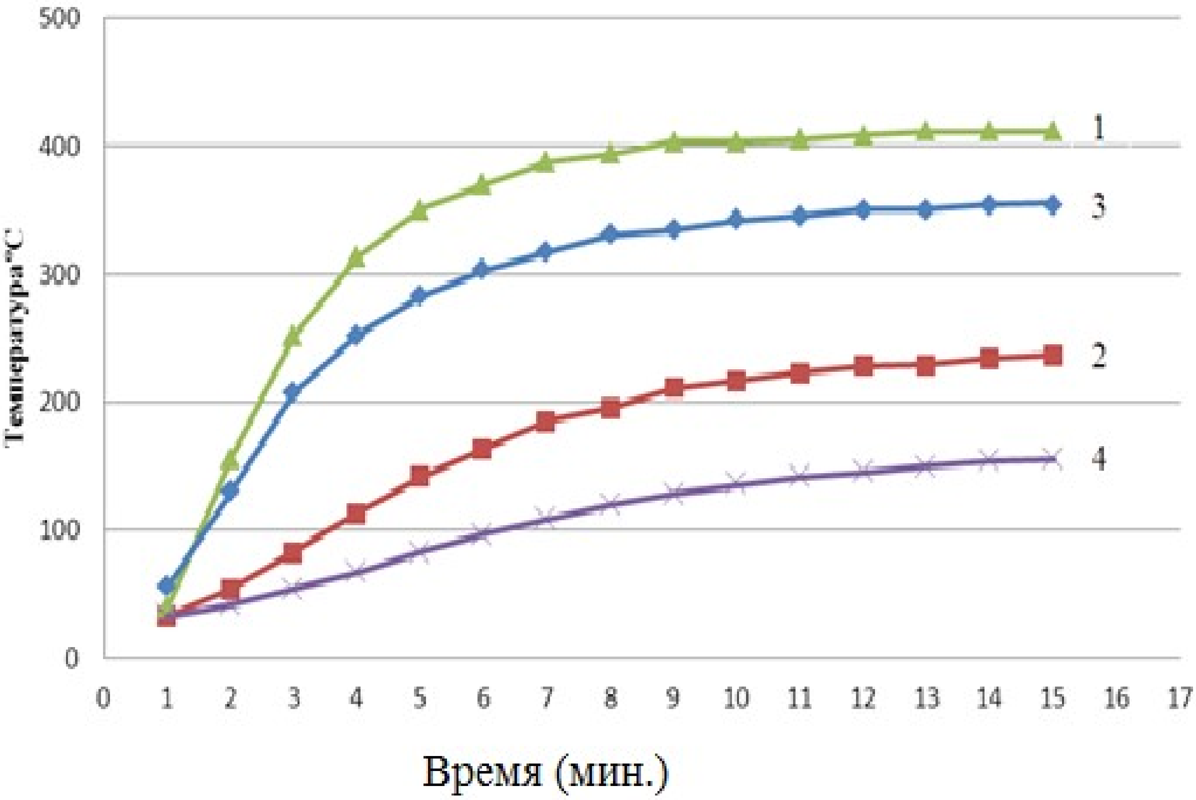

Fig. 3. Graph of the image of the thermal conductivity of the composition based on cement, hydrophobic thermovermiculite and sand

In both figures (Fig. 1), curves 1- and 2- are indicators of temperature differences in measuring the surface of a coated metal, as well as curves 3- and 4- indicators of temperature differences in measuring a metal surface without coating. The obtained values (table data and curves of figures) thermal conductivity measurements show that the developed new porous materials based on local mineral raw materials have effective fire and heat protection properties. Thus, the data obtained prove the expediency of using local mineral raw materials for these purposes[3,4].

Table 2. Indicators of measuring the surface temperature of metal with a new fire and heat-shielding composition

№	Uncoated metal surface temperature index		Coated metal surface temperature index	
Time (min)	$T_{in.}$ (ºC)	$T_{out.}$ (ºC)	$T_{in.}$ (ºC)	$T_{out.}$ (ºC)
1.	57,5	34	60	30
2.	86,5	44,5	89,5	39,5
3.	108	53	115	48,5
4.	124,5	68,5	136	57
5.	139,5	80,5	153,5	66
6.	152	90	169	75,5
7.	163	99,5	182,5	85

8.	172	108	194	93,5
9.	196,5	115	203	103
10.	201	117	208,5	107,5
11.	204,5	122,5	214,5	112
12.	206	125,5	221	116,5
13.	208,5	128	222	118
14.	211	131,5	225	121
15.	214,5	132,5		
16.	215	134		
17.	218	135,5		
18.	221	138		
19.	222,5	138,5		
20.	223	139		
21.	223	140		

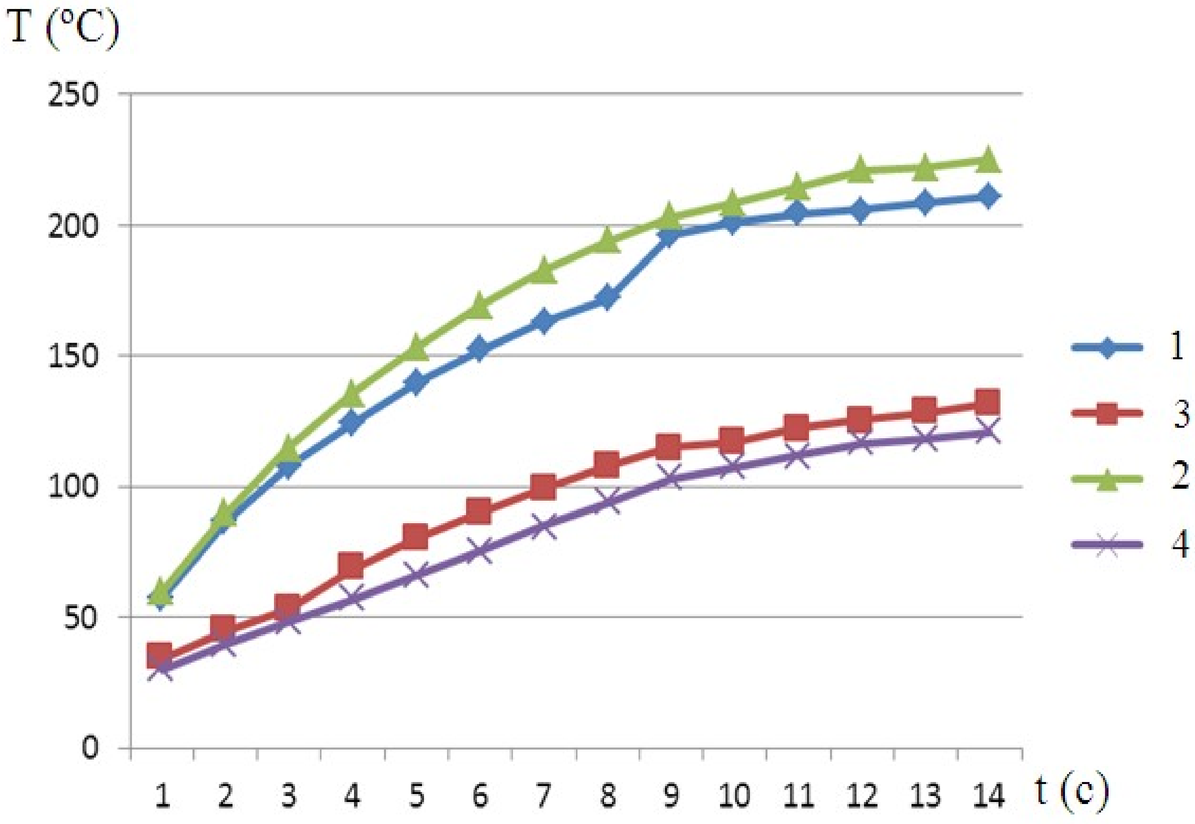

Fig. 4. Image plot of the thermal conductivity of a composition based on cement, sodium carboxymethyl cellulose, glass sand, silica fume, porous component, finely dispersed wollastonite and basalt fiber.

For the preparation of fire-resistant compositions, swelling is one of the main processes, the formation of which requires a certain proportion of thermal energy, and there is a certain delay in the advancement of the combustion front. Obviously, the degree of delay in time is determined by the specific fraction of the volume of the air gap and the amount of water vapor that needs to be heated to high temperatures. And since the specific heat capacity of water is quite high, it takes a certain amount of time to convert water into steam, then heat it up and remove it. Thus, the fire-retardant function of vermiculite in all fire-resistant compositions is determined by its ability to actively convert the water in the interlayer volumes into steam with the expansion of the anion-cationic layers and a significant increase in the volume of the sample, with the formation of an air-water layer as a fire retardant barrier in the path of flame propagation [5,6].

In accordance with the foregoing, a fire and heat-protective coating based on cement, sodium carboxymethyl cellulose, glass sand, microsilica, a porous component, finely dispersed wollastonite and basalt fiber was developed and an experiment was conducted to identify its effectiveness in protecting metal structures. According to regulatory documents, the effectiveness of fire retardants for steel structures is determined in in accordance with NPB 236-97 "Fire retardants for steel structures.

General requirements. Method for determining fire retardant efficiency. The test method for fire resistance according to NPB 236-97 consists in the thermal effect on a prototype and the determination of fire and heat protection efficiency. In order to find effective ways to protect against thermal effects on metal structures, we conducted studies to evaluate the effectiveness of protection of the obtained materials [7,8].

Effective compositions have been developed for obtaining coatings based on the designed vermiculite powder and an experiment was carried out to identify its effectiveness when protecting metal structures. Composite modules of such an experiment conducted under these conditions comply with the requirements of the NPB 236-97. The composition of the studied flame retardant composition, the following: cement, sodiumcarboxymetlcellulose, sand glass, microcremneosis, porous component, fine vollastonite and bay fiber. The time during which the metal plate was heated and the temperature was fixed from the opposite side, was 150 minutes. The temperature of the metal plate was determined using the thermocouple chromel-aluminum. Visually after two hours of heating, the coated plate was not detected by any noticeable disorders of the coating[8].

Thus, the tests of protective compositions and the study of their fire and heat-shielding qualities allowed us to draw the following conclusions: due to the effective heat-resistant coating of the new compound, it is capable of increasing the heat resistance of metallic confouctions and products from a critical temperature of 500 ° C to 1200 ° C, which lengthens fire resistance Metal.

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