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IMPROVEMENT OF METHODS FOR INCREASING THE FIRE RESISTANCE OF WOOD MATERIALS

Lityaga Artem Valerievich
Associate Professor of the Department of the Academy of the Ministry of Emergency Situations, PhD, Associate Professor

Khalilov Khusan Shukrulla ugli
Independent applicant of the Academy of the Ministry of Emergency Situations

Annotation
In this article, the methods of testing textile and wood materials impregnated with flame retardants of the AC and ACB brands, which are a suspension based on vermiculite and orthophosphoric acid, are given. In addition, the test data of the flame propagation velocity and the burning time of the samples, as well as the smoke formation of these materials, are given.

Keywords: flame-retardants, phosphoric acid, wood, textile materials.

Providing fire safety is an important state task. Wood and textile materials (TM) are widely used in all sectors of the economy, however, along with numerous advantages, they have an increased fire hazard. Especially the risk of fire with tragic consequences increases in places of mass stay of people - hotels, hospitals, schools, child care facilities, railway transport, airplanes, cars, etc. [1].

Concerning earlier at the Department of General Chemistry of the Toshkent State Technical University named after Islam, a fire retardant composition based on orthophosphoric acid and vermiculite was developed to protect wood and textile materials. For wood samples, not expanded vermiculite was used, but expanded vermiculite for textile samples.

During the preparation of the samples, we used the antiseptic method, that is, applying a fire-retardant suspension with a brush in three layers to the wood, and the textile samples were wrapped in the suspension. After each application and deboning, the samples were kept in a ventilated drying cabinet of the ShS-80-01 MK SPU brand for 20 hours at a temperature of (60 ± 5) ° C, then they were cooled to ambient temperature without removing them from the cabinet.

In order to determine the spread of the flame over a horizontally fixed sample, a standard method was used to determine the resistance to combustion (GOST 28157-

89) [2]. The tests were carried out on five specimens with shaped bars 125 mm long, 13 mm wide and 10 mm thick.

Fig. 1. Appearance of samples after testing

The burning rate υ, mm / min, of each sample was calculated by the formula:

$$\upsilon = \frac{60L}{t},$$

L -length of the burnt part, mm;
t -burning time, s.

According to GOST 28157-89, for specimens less than 3 mm thick, the burning rate should not exceed 75 mm / min. Based on GOST 28157-89, it can be concluded that samples of textile material impregnated with fire retardants No. AP-1 are not included in the class that spreads the flame [11].

In order to determine the group of hardly combustible and combustible solids, the standard method of experimental determination of the group of hardly combustible and combustible solids and materials (GOST 28157-89) was used. The tests were carried out on 3 samples of material 60 mm long, 150 mm high and 30 mm thick.

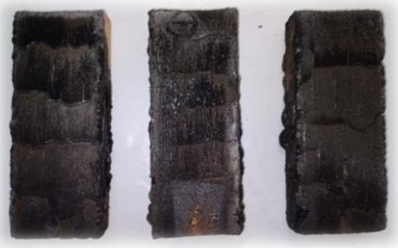

Fig. 2. Appearance of samples after testing

After obtaining the data, two similar tests were carried out with new samples.

The maximum temperature increment (Δt_{max}) was calculated by the formula:

$$\Delta t_{max} = t_{max} - t_0,$$

where t_{max}-is the maximum temperature of the gaseous combustion products of the test material, °C;

t_o - initial test temperature equal to 200 ° C.

The weight loss of the sample (Δm) in percent was calculated by the formula:

$$\Delta m = \frac{m_н - m_к}{m_н} \cdot 100,$$

where $m_н$ - sample weight before testing, g;

$m_к$ - sample weight after testing, g.

According to the value of the maximum temperature increase $\Delta t\ max$ and weight loss, materials are classified:

hardly combustible - $\Delta t\ max$< 60 °C or Δm < 60 %;

combustible - $\Delta t\ max$≥ 60°C or Δm ≥ 60%.

The arithmetic mean of three determinations, rounded to 1%, is taken as the test result.

The results of this test showed that the arithmetic average weight loss of specimens coated with a fire retardant composition is 0.6%, therefore they are classified as non-combustible materials, according to GOST 12.1.044-89.

In order to determine the smoke-generating ability of materials, we used the standard experimental method for the smoke production coefficient of solids and materials (GOST 12.1.044-89) [3-5]. Tests were carried out on 10 wood samples, as well as 10 samples of textile material (40x40) mm in size and actual thickness, but not more than 10 mm [12].

Before testing, prepared samples are kept at a temperature of (20 ± 2) ° C for at least 48 hours, then weighed with an error of not more than 0.01 g. Samples should characterize the average properties of the material under study [6-8].

Fig. 3. Appearance of samples after testing

The smoke production coefficient (Dm) in m² kg-1 is calculated by the formula:

$$Dm = \frac{Vn}{lm} 1n \frac{T^0}{T_{\min}}$$

where$V$- is the volume of the measurement chamber, m3;

L -is the length of the path of the light beam in a smoky environment, m;

m -is the mass of the sample, kg;

T_o,T_{min}- respectively the values of the initial and final light transmission,%.

As follows from table No. 4, the average indicators of the degree of smoke generation of the studied samples of wood materials impregnated with phosphorus-vermeculite containing a fire retardant suspension are equal to DAP-1sr ≈ 42.6 m^2 /kg. According to GOST 12.1.044-89, the material under study with a low smoke-generating ability is the coefficient of smoke production up to 50 $m^2 \cdot kg^{-1}$ incl [10].

As follows from table No. 5, the average indicators of the degree of smoke generation of the test samples of test materials impregnated with phosphorus-vermiculite containing a fire retardant suspension are equal to DAP-1sr ≈ 0 m^2 / kg. According to these results, the test material does not emit smoke.

The results obtained on the creation of fire-resistant impregnation and fillers based on local mineral raw materials have the following implementation facts:

a new composition of the paint material, developed on the basis of the local mineral Tebinbulak vermiculite, which effectively protects wood materials from fire, has been put into production at CLOBAL-BUILDING-GROUP LLC (minutes dated April 28, 2021 No. 148 of the Testing Center of the Research Institute of Fire Safety and problems of emergency situations of the Ministry of Emergency Situations of the Republic of Uzbekistan, act dated August 2, 2021 LLC "CLOBAL-BUILDING-GROUP", certificates dated September 22, 2021 No. 05/15-2347 of Qurilishmateriallari JSC and dated November 1, 2021 No. 09- 05/12440 of the Ministry of Construction of the Republic of Uzbekistan).

As a result, the obtained new effective fire-retardant, heat-insulating paint and varnish materials and flame retardants made it possible to transfer building materials from the combustibility group (G4) to the group of slow-burning (G1), as well as an increase in the value of the critical smoldering time of wood materials from 14 minutes to 18-19 minutes, i.e. improvement of at least 1.1 times, made it possible to increase the strength of wood structures by 1.1%, heat resistance by 1.1-1.15%, as well as scientifically proven the possibility of lowering the smoke generation coefficient to 1.2%, reducing the flame propagation rate by 1.2 times, in addition, the annual economic effect from the use of these flame retardant-modified paints and varnishes amounted to 560,000 000 (five hundred sixty million) soums.

Conclusion

Summing up, it should be noted that the studied materials of wood and textiles impregnated with a three-layer flame retardant suspension have fire retardant efficiency. The use of phosphorus-vermiculite containing flame retardants offered by us as coatings and impregnation agents for building wood structures and textile materials makes it possible to slow down the spread of flame during a fire, helps to

reduce material damage, and also reduce smoke emission and thereby save people's lives.

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