

Use of intumescent compounds in fire curtains

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Abstract. Automatic fire curtains are designed to divide sections of premises and structures into fire compartments for the purpose of localizing a fire, as well as filling openings in fire barriers. If a fire occurs due to a signal from a fire alarm sensor or a signal from a fire station, the blind automatically falls and locates the source of ignition. The paper presents the results of testing nine samples of fire curtains with an applied intumescent composition. Tests were conducted for 60 minutes before loss of sample integrity. The average temperature from the heated side of the sample reached 800 ~ 1000 ° C. Depending on the sample, the temperature from the unheated side ranged from 70 ° C to 294 ° C. The best result was shown by a sample from a layer of needle-punched heat-insulating material with a thermal conductivity of 0.036 W/(m×K) placed between layers of foil and treated with water-based intumescent composition of silica material.

1. Introduction

The practice shows, what most effective way to ensure the safe evacuation of people in case of fire and to preserve material values are the measures established by Russian Federal Law No. 123-FZ to limit the spread of fire, within the framework of which it is envisaged the installation of fire barriers - building structures with a standard fire resistance limit [1].

Fire protection is aimed at finding the most effective, economically feasible and technically sound methods and means of preventing fires and their elimination with minimal damage with the most rational use of forces and technical means of extinguishing.

Automatic fire curtains [2 - 4] are designed to divide sections of buildings and structures into fire compartments for the purpose of localizing a fire, as well as filling openings in fire barriers. If a fire occurs due to a signal from a fire alarm sensor or a signal from a fire station, the blind automatically falls and locates the source of ignition.

Such curtains from a fire-prevention cloth are made, which consists of their fiberglass (silica or basalt fiber). In the initial position, the firewall is wound on a shaft of steel. The shaft is housed in a galvanized casing made of steel sheet. Mounted on a wall, ceiling, suspended ceilings. The curtain fabric at the lower end has a special cut-off bar. It allows you to keep the canvas unfolded. Bottom edges do not bend, do not let smoke pass. In the collapsed condition, the tire is hidden among the recesses of the hull structure. Fireproof curtains are often designed as part of engineering and technical measures when developing special technical conditions [5 - 6].

Traditional fire protection solutions with curtains:

- separation of spaces into fire compartments;
- overlapping of window, door, elevator and other openings;



- fencing atriums, escalators, stairs;
- as a fire curtain for the separation of the auditorium and the stage space;
- formation of pockets for collecting smoke in the under-ceiling space;
- protection against fire from nearby and adjacent buildings;
- protection of openings in fire walls, incl. when devices are installed in them;
- protection of places of increased fire danger;
- as an alternative to glass fire barriers, fireproof windows and fireproof gates.

Fireproof curtains are used in production and logistics complexes, in parking lots and at gas stations, at railway stations, in film-concert complexes, museums, in hotel, trade and multifunctional complexes.

The aim of paper is to study the temperature field from the unheated side of the fire curtain.

2. Methods

Testing of experimental samples of fire curtains with intumescent composition was carried out to determine the limiting states of samples, based on the test method of the national standard of Russia 53307-2009 Fire doors and gates. Test methods for fire resistance [9 - 10] with certain assumptions. Samples of fireproof curtains were made in the size of 0.1×0.1 m and mounted on a metal frame with a combustion chamber. A compressed propane-butane-isobutane mixture was fed into the combustion chamber at a flow rate of $0.0055 \text{ m}^3 / \text{min}$, the combustion chamber volume was 0.001 m^3 . The temperature of the environment was in the range of $18\text{-}25^\circ \text{C}$.

Tools, equipment for testing.

- gas-burner;
- Stopwatch;
- pyrometer ADA TemPro 550.

Before the test, a visual inspection of each sample was carried out for uniformity and homogeneity of the application of the flame retardant coating, the color of each sample was fixed. The tests were performed alternately for each sample. The sample was fixed around the perimeter of the fire chamber. When the burner was switched on, the stopwatch was turned on at the same time. The flame temperature of the burner is up to 1200°C . Sample hold time 60 min. During the experiment, visual observation of the sample was carried out and recorded:

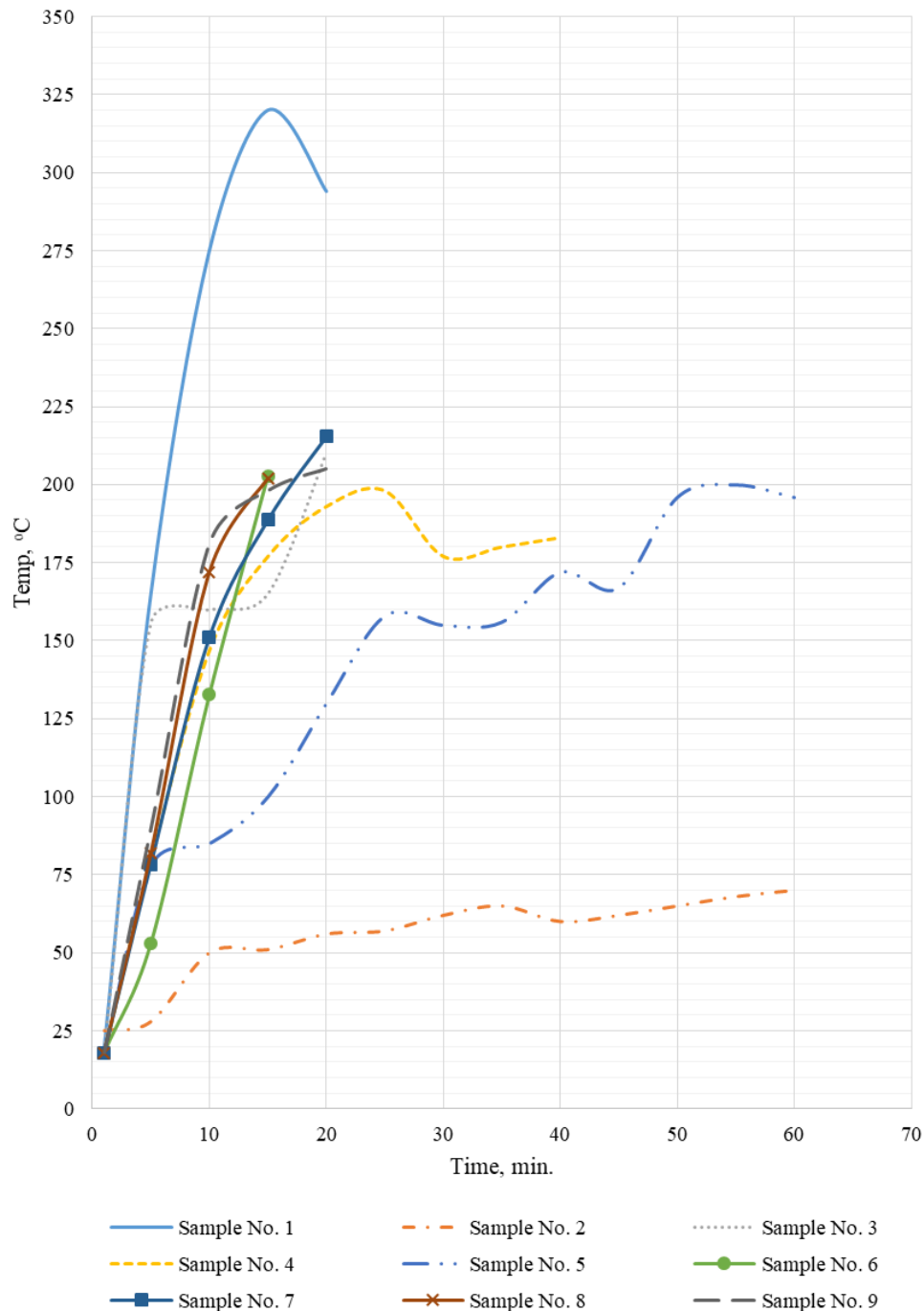
- sample integrity;
- temperature 200°C from the unheated side.

At the end of the experiment, the area of flame damage was measured. Based on the test results, the temperature curves are plotted (Figure 2).



Figure 1. Coke foam layer on sample No 4

Temperature test curves

**Figure 2.** Temperature test curves

3. Results

Sample No. 1 - the silica material was treated on both sides with a silicone sealant resistant to temperatures up to 400 °C, a uniform layer of an intuessant composition on a water basis is applied from the top of the sealant. For 20 min. the intumescent compound exfoliated from the surface of the sealant, the tests were suspended due to loss of integrity. Sample No. 2 is a layer of needle-punched

heat-insulating material with a thermal conductivity of $0.036 \text{ W} / (\text{m} \times \text{K})$ placed between the foil layers and the treated intumescent composition on a water-based silica material. At 60 minutes, no signs of loss of integrity were detected, the temperature from the unheated side of the sample was 60 minutes. reached 70°C . Sample No. 3 - a layer of needle-punched heat-insulating material with a thermal conductivity of $0.036 \text{ W} / (\text{m} \times \text{K})$ is placed between the foil layers and the silica material. For 20 min. The temperature from the unheated side of the sample reached 210°C . Sample No. 4 - silica material was treated on both sides by an intumescent composition on a water basis. At 40 min. Signs of loss of integrity were recorded, the temperature from the unheated side reached 183°C , a strong foam coke layer was formed (figure 2). Sample No. 5 is a five-layer specimen consisting of alternating layers of foil and parchment paper, filled between layers with a water-based intumescent composition. At the end of the test, the temperature from the unheated side reached 196°C , there were no signs of integrity violation. Sample No. 6 - a water-based intumescent composition without TiO_2 is embedded between the two layers of silica tissue. By the 15th minute of the test, the temperature from the unheated side reached a value of 202.8°C . Sample No. 7 - an intumescent compound on an acrylic base is placed between two layers of silica fabric. By the 20-minute test, the temperature from the unheated side reached a value of 215.4°C . Sample No. 8 - a glass mat is enclosed between two layers of silica fabric. By the 15th minute of the test, the temperature from the unheated side reached 202°C . Sample No. 9 - a water-based intumescent compound is enclosed between two layers of silica tissue. By the 20-minute test, the temperature from the unheated side reached a value of 205°C .

4. Conclusions

In the study, nine samples of fire curtains with different configurations were tested. Based on the results of tests performed, it can be seen that sample No. 2 (a layer of needle-punched heat-insulating material with a thermal conductivity of $0.036 \text{ W} / (\text{m} \times \text{K})$ placed between layers of foil and treated with an intumescent composition of water-based silica material) has better characteristics and, based on it, a fire shutter for full-scale experiment [11 ± 12]. Sample No. 2 for its design features is most closely described in patent RU2614710C1, but excluding the use of thermosetting silica material with a thickness of 0.7 mm specified in this patent. Sample No. 2 consists of a silica material without a preliminary heat treatment for shrinkage, 2 mm thick with a uniform coating of an intumescent composition not more than 1 mm thick. The worst result was shown in sample No. 1 (the silica material was treated on both sides with a silicone sealant resistant to temperatures up to 400°C , a uniform layer of intumescent composition on a water basis is applied on top of the sealant), this result is associated with low adhesion of the silicone surface with intumescent paint. Because of the premature "slipping" of the intumescent layer, the thermal insulation capacity of the sample structure was impaired [13].

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