Under the thermal action on wood when applying a protective screen made from fire-retardant fabric, the process of temperature transfer is natural. It has been proven that depending on the thermal properties of the coating of fire-proof fabric, this could lead to varying degrees of heat transfer. Therefore, it becomes necessary to study the conditions for establishing low thermal conductivity and establishing a mechanism that inhibits heat transfer to wood. Given this, a mathematical model has been built of the process of heat transfer to wood when it is protected by a screen made of fire-proof fabric. According to the experimental data on determining the temperature on the non-heated surface of the fabric and the resulting dependences, the density of the heat flow transmitted to wood through fire-proof fabric was determined. Thus, with an increase in the temperature, the density of the heat flow to the surface of the wood through a protective screen made of fire-proof protected coating based on "Firewall-Attic" increases to a value above 16 kW/m^2, which is not sufficient for ignition of wood. Instead, the density of the heat flow through the protective screen of fire-proof fabric protected by the "Firewall-Wood"-based coating did not exceed 14 kW/m^2. This makes it possible to argue about the compliance of the detected mechanism of formation of heat-insulating properties in the protection of wood and the practical attractiveness of the proposed technological solutions. Thus, the peculiarities of inhibition of the process of heat transfer to wood through a protective screen made of fire-proof fabric under the action of a radiation panel imply the formation of a heat-insulating layer of coked cellular material when decomposing the coating. Thus, on the surface of the fire-proof fabric, a temperature above 280 °C was achieved and, on an untreated surface of the fabric, it did not exceed 220 °C, which is insufficient for the ignition of wood

Keywords: fire protection of wood, swelling coating, thermal conductivity, surface treatment, thermal-physical properties

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DEFINING PATTERNS OF HEAT TRANSFER THROUGH THE FIRE-PROTECTED FABRIC TO WOOD

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1. Introduction

The operational safety of storage facilities is closely related to the use of a wide variety of finishing and packaging articles made of wood, paper, and textile materials. This is due to the fact that these materials are sensitive to the effects of high temperature, so it is possible to increase the level of fire safety of facilities through their fireproof treatment.

To properly protect the above materials from the ignition, mixtures of inorganic salts are used; however, fireproof treatment is not suitable for them since the formation of efflorescence is observed on the surface, likely to detach later. Over time, the material loses its protective properties, which leads to the ignition of combustible articles exposed to fire. The use of screens made of fireproof fabric makes it possible to slow down the warming up of the material due to the formation of an insulating layer of coked cellular material when the coating swells at high temperatures.

Thus, the peculiarity of fire protection of natural combustible materials, for example, wood, is to create, at the surface of the structural elements made of timber, protective screens that withstand high temperatures and the direct effect of fire. In addition, the presence of such screens makes it possible to slow down the heating of the material and preserve its functions in the case of fire over a predefined period, thereby making timber, for example, a non-combustible material.

Therefore, it is a relevant task to conduct a study aimed at reducing the level of fire danger of wood by using protective screens made of fire-proof fabric, which wraps timber, the formation of a layer of coked cellular material during the thermal decomposition of the swelling coating.

2. Literature review and problem statement

Paper [1] argues that fireproof coatings on an inorganic base improve the fire resistance of textile materials in the production of structures. In this regard, a composite was proposed, which is strengthened with cement-based fabric prepared by filling the porous surface of a three-dimensional fabric, but it is characterized by rigidity. However, there is a need to improve the compression strength of fire-resistant textile products, as well as their bending strength, wear resistance, anti-penetration efficiency.

One of the new materials is hybrid textiles modified by carbon nanotubes. In [2], textiles were modified by introducing dimethyl phosphate and perfluorohexyl iodine applied to cotton for fireproof, water-repellent resistance, and resistance to ultraviolet light. The properties of combustion of textiles were estimated by using a micro-scale combustion calorimeter, a heat matching test, and thermogravimetric analysis. The hydrophilic surface and the hydrophobicity of the fabric surface were characterized by a static angle of contact, and the resistance of the fabric to UV radiation was represented by the value of the Ultraviolet Protection Factor. According to miniature combustion heat meters, both the value of the maximum heat transfer rate and the total heat generation was about 65 % lower than that of unprocessed cotton fabric. The modified fabric has fireproofed, ultraviolet-resistant properties. However, to confirm the effectiveness, the relevant physicochemical data on the washing out of flame retardants during operation are not provided.

The data from [3] emphasize the modification of graphene oxide by introducing dimethyl phosphate and perfluorohexyl iodine. The dimethyl-phosphate hydrophobic agent was improved compared to untreated cotton but was no better than the fabric treated with perfluorohexyl chain grafted with these flame retardants. The modified fabric has fireproofed, UV resistant and hydrophobic properties. However, it was not defined which classes of operation those substances belong to.

Work [4] shows protection against ultraviolet radiation and the hydrophobic protection of fabric by modifying cotton fabric with graphene oxide and silane binding agent through immersion-laying-drying. As a result, the cotton fabric was successfully modified with graphene oxide and silane agent and, compared to untreated fabric, the surface of the fabric was smooth and there were no gaps on the fiber. Excellent protective properties from ultraviolet, as well as hydrophobic properties, were obtained. After treating by a silane binding agent, the hydrophilic fabric treated with graphene oxide becomes hydrophobic, and graphene oxide is bound to cotton. However, the issues related to the protection mechanism remain unresolved. The reason for this may be the subtleties regarding the formation of a protective layer, which, accordingly, makes such studies complicated.

Nanocomposites, formed from cation starch and clay, gave fire-protective properties to pure cotton fabric by layer-by-layer application [5]. In this case, starch and clay multilayer thin films were used to increase the thermal stability of fabric and improve fireproof properties by forming a layer of ceramic coal and a heat-resistant carbon structure at high temperatures. Cone calorimetry revealed a lower value of the thermal irradiation of fabric covered in two layers with a flame retardant. Samples of cotton with a two-layer flame-retardant coating showed reduced combustion time during tests. However, the impact of environmental changes on the coating, its destruction in time, were not considered.

Study [6] aims to discuss the use of a new composition based on sodium silica, urea, and sodium phosphate to provide fire-protective properties to cellulose textiles. During combustible testing, untreated fabric completely burns out in 60 s during ignition. Electron scanning microscopy and energy dispersion microanalysis revealed that pure cotton fabric contains 68.77 % of carbon and 31.22 % of oxygen. After modification, the particles of sodium, 0.02 %, phosphorus, 0.04 %, and potassium, 0.05 %, are formed on the surface of the treated fabric. It has been shown that in cellulose materials modified with compositions based on sodium silica and urea, sodium hydro phosphate, fire-protective properties improve. However, with an increase in the concentration of flame retardant and the heat treatment temperature, the breaking load of the fabric decreases.

Several boron-nitrogen polymers are reported in [7] to ensure the fire-resistant treatment of cotton fabrics. The organic combination of boron, phenylboronic acid was successfully associated with branched polyethyleneimine and was confirmed by the analysis. Thermogravimetric analysis showed that the polymer in the mole ratio of 1:1 of ethylene and a flame retardant demonstrates optimal thermal oxidation stability, easily applied to cotton fabrics by immersion with high absorption in the acetone medium. Fabric with the addition of 33.8 wt % has a self-extinguishing capability. Analysis of the morphology of calcinating the treated fabrics revealed their fire resistance due to the fire-protective mechanism of swelling flame retardants. However, operations on fire protection of fabrics require special equipment for the treatment of fabric.

Paper [8] describes the use of the sol-gel method. If one takes tetraethyl orthosilicate and ethanol as a solvent and hydrochloric acid, catalyst, methacryloxypropyltrimethoxysilane as a binder for SiO_2 preparations, then one obtains a phosphorus flame retardant and sol to improve the fire resistance of cotton fabrics. The fabric was treated by immersion-baking. The morphology of the surface and the distribution of elements, the internal crystalline structure, pyrolysis, and the fire resistance of cotton fabrics were characterized by scanning electron microscopy, Fourier-transform infrared spectroscopy, X-ray photoelectron spectroscopy. The results show that the treated fabrics have a good synergistic fire protection effect. Cotton fabric treated with hybrid sol demonstrates the best fire-protection effect; its oxygen index is 22.8 %. Hybrid sol containing phosphorus flame retardant can contribute to the formation of three-dimensional microscopic gel coating and residual coal in the condensed phase. However, it should be noted that the cited work does not describe the physicochemical conditions for the formation of the coating. This means that it was not determined how the process of creating a coating on the fabric proceeds.

Materials containing cellulose are dangerous for fire and, in case of fire, increase the fire load [9]. The influence of the type of a flame retardant based on alumochromophosphates, as well as the duration of impregnation on the reduction of combustibleness, and the temperature of impregnated textile materials during their combustion was investigated. A decrease in the proportion of destroyed fabric of less than 20 % was established. However, there is a need to fix the flame retardant in the material.

Paper [10] reports melamine-based resins, which are widely used in fabrics to increase their fire and heat resistance. Modeled experiments that involved the washing of fire-proof fabrics suggest that in one round of washing with water, 76–90 % of melamine was removed from clothing. At the same time, the authors did not specify by how much the combustion of the composition of fabric and resin is reduced.

The influence of SiO_2 sol homogeneity on the duration of the induction period and the quality of fire-protected coatings for fabrics was investigated in [11]. Prospects for the use of IR spectroscopy as an express method for studying the phase composition of the gel coating, the degree of completion of the hydrolysis of the organosilicon component have been shown by a system of the flame retardant based on SiO_2. However, the issues related to the mechanism of formation of fire protection coating remain unresolved. The reason for this may be the subtleties regarding the formation of a protective layer, which, accordingly, makes such studies complicated.

Thus, it was established that flame-retardant coatings can protect the surface of textile material from the effects of a fire during operation but no parameters for the heat transfer through the thickness of the fabric were defined.

In addition, the parameters that ensure resistance to the loss of fire-resistant properties were not determined; neglecting the use of organic substances to form a swelling layer of coked cellular material leads to inefficient use of fire protection means. Therefore, the use of screens that protect wood, made of fire-retardant fabric, as well as the study of heat transfer through the screen under thermal action, necessitated research in this area.

3. The study materials and methods

The purpose of this work is to identify patterns of formation of a heat-resistant screen when the fireproof fabric is exposed to high temperatures. This could make it possible to substantiate the use of use of fire-retardant fabric at the storage facilities of combustible wooden articles.

To accomplish the aim, the following tasks have been set:

– to model the process of thermal conductivity of the protective screen of fire-proof fabric when timber is exposed to thermal effect;

– to establish features in reducing the thermal conductivity of the protective screen made of fabric protected by a swelling coating under high-temperature exposure.

4. The study materials and methods

4. 1. The examined materials used in the experiment

To establish the fireproof effectiveness of the protective screen made of fireproof fabric, we used samples of sailcloth the size of 300×120 mm.

The samples were treated with the modified impregnation solution “Firewall-Attic”, based on a mixture of organic and inorganic substances, for fire protection of wood, manufactured in Ukraine. This composition (a mixture of urea 28...30 % and phosphoric acids 23...24 %) was modified by starch in the amount of 20 %; we also used the swelling coating “Firewall-Wood”, made in Ukraine (Fig. 1).

a *b*

Fig. 1. Model samples of fabric for testing, protected by coatings: *a* — based on “Firewall-Attic”; *b* — based on “Firewall-Wood”

The resulting mass was mixed and applied onto a fabric sample in the amount of 137.0... 140.0 g/m^2 [12]. In this case, the fireproof coating penetrated the structure of the fabric and formed an elastic film at the surface, about 20 μm thick.

4. 2. Procedure for determining the indicators of heat transfer by a protective screen made of fire-proof fabric to timber

We determined the protective efficiency of coating for fabric according to the devised procedure whose essence was to experimentally define the temperature on the surface of a timber sample. Namely, the influence of the radiation panel with the set parameters such as fire-retardant fabric and recording the temperature on the non-heated surface of the fabric during the test.

To derive the thermal conductivity values of the coating for fabric, special equipment was designed and manufactured; we used the flame of a radiation panel [13], which simulates a high-temperature ignition source (Fig. 2).

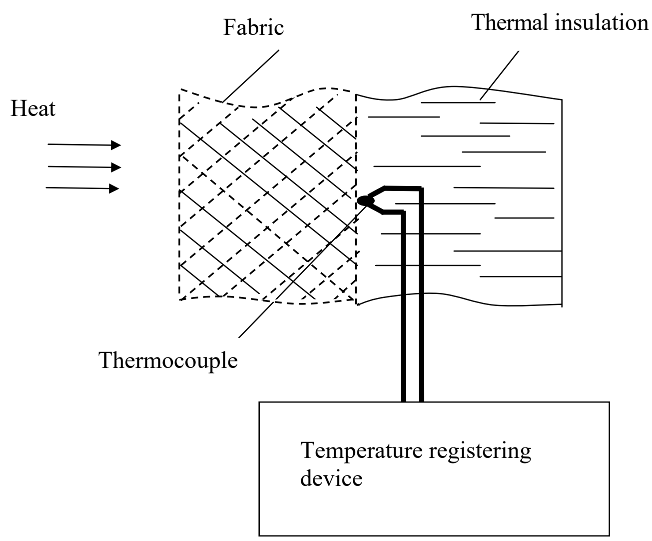

Fig. 2. Device for testing the thermal conductivity of the fire-proof fabric

A fabric sample, protected by the coating, was placed in the specimen holder. The sample was fixed so that the end of the thermocouple was pressed against the non-heated surface of the fabric sample. The sample was placed in a test chamber and kept in the flame of the radiation panel for 600 s. We controlled the temperature at the fabric surface.

Based on the measured values of the temperature, we registered the changes and the amount of heat flow transmitted to the fabric during the action of the radiation panel [14].

The research on modeling the process of thermal conductivity of fire-proof fabric under thermal action was carried out using the main provisions from mathematical physics [15].

5. Results of studying the process of thermal conductivity of fire-proof fabric when protecting timber

5. 1. Modeling the process of thermal conductivity of fire-proof fabric when protecting timber

As a result of treating the fabric with protective coatings under the action of the heat flow, the direction of heat transfer changes since the thermal insulation layer is largely capable of absorbing heat. Given this, the question arises regarding the study of heat flow at the "coating – fabric" interface under the action of heat.

In order to establish the effect of the heat flow to the fireproof fabric, a method was proposed for solving the thermal conductivity problem for a two-component wall with various thermal properties (Fig. 3). At the initial moment, the outer surface of the coating is instantly heated to the temperature T_{max}, which is maintained constant throughout the entire heating process. Temperature distribution passes through the coating until the critical temperature of the fabric at the "coating timber wall" interface T_s is reached [16]. And considering the insignificant thickness, this temperature is inherent in the entire thickness of the fabric.

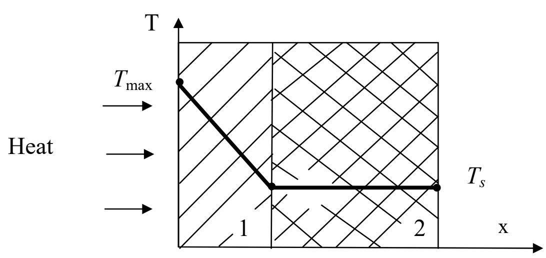

Fig. 3. Schematic heat transfer process: 1 – coating; 2 – fabric

The differential equations of heat transfer at the boundary of two plates "coating – fabric" take the following form [17]:

$$\left(\frac{\partial}{\partial t}-\phi_1^2\frac{\partial^2}{\partial x^2}\right)T=0,\ \ (-\infty<x<0), \tag{1}$$

$$\left(\frac{\partial}{\partial t}-\phi_2^2\frac{\partial^2}{\partial x^2}\right)T=0,$$

$$(0<x<\infty;\ 0<t<\infty), \tag{2}$$

under the following initial and boundary conditions

$$T\big|_{x=-\infty}=T_0,\ \ T\big|_{x=\infty}=0,\ \ T\big|_{x=-0}=T\big|_{x=+0}, \tag{3}$$

$$\lambda_1\frac{\partial T}{\partial x}\bigg|_{x=-0}=\lambda_2\frac{\partial T}{\partial x}\bigg|_{x=+0},\ \ T\big|_{t=0}=\begin{cases}T_0,\ \text{at}\ x\prec 0,\\ 0,\ \text{at}\ x\succ 0.\end{cases} \tag{4}$$

$$T_0,\ \phi_1,\ \phi_2,\ \lambda_1,\ \lambda_2=\text{const}, \tag{5}$$

where T is the temperature, °C;

x – coordinate, m;

$\phi=\sqrt{a}$;

a_1, a_2 are the temperature coefficients of the coating and fabric, $m^2 \times s^{-1}$;

λ_1, λ_2 are the coefficients of thermal conductivity of the coating and fabric, $W \times m^{-1} \times °C^{-1}$.

It is required to find the temperature value at the "coating – fabric" interface, T_s, and, accordingly, the value of the heat flow between these regions:

$$Q_0=\lambda_2\frac{\partial T}{\partial x}\bigg|_{x=+0}. \tag{6}$$

Given that for the left-hand part of the model (Fig. 3), at $x<0$, the initial condition is not zero, a substitution can be made:

$$T=T_0-T^*, \tag{7}$$

where T_0 is the maximum temperature at the "coating – fabric" interface.

After that, the problem of determining the temperature T^* is written in the following form:

$$\left(\frac{\partial}{\partial t}-\phi_1^2\frac{\partial^2}{\partial x^2}\right)T^*=0,\ \ (-\infty<x<0, 0<t<\infty), \tag{8}$$

under the condition

$$T^*\big|_{x=-\infty}=0,\ \ T^*\big|_{t=\infty}=0. \tag{9}$$

For the region $x<0$, taking into consideration the Laplace transformation, a relation between the temperature and heat flow can be established in the following form [18]:

$$\left(P^{1/2}-\phi_1\frac{\partial}{\partial x}\right)\cdot T^*\big|_{x=0}=0, \tag{10}$$

where P is the Laplace operator.

Considering the initial variable T, we obtain:

$$P^{1/2}\left(T_0-T_s\right)=\frac{T_0}{\sqrt{\pi\cdot t}}-P^{1/2}\cdot T_s=-\phi_1\frac{\partial T}{\partial x}\bigg|_{x=-0}. \tag{11}$$

For the region, at $x>0$, one can write, respectively:

$$P^{1/2}T_s=-\phi_2\frac{\partial T}{\partial x}\bigg|_{x=+0}. \tag{12}$$

From equations (11) and (12), subject to the equality of flows (4), we obtain:

$$P^{1/2}T_s=\frac{\phi_1}{\phi_1+\phi_2}\frac{T_0}{\sqrt{\pi\cdot t}}. \tag{13}$$

Taking into consideration the Laplace transformation at the wall boundary, we obtain the following temperature value:

$$T_s=\frac{\phi_1}{\phi_1+\phi_2}\cdot T_0. \tag{14}$$

Then, according to (6), the heat flow at the boundary, at the maximum temperature, is determined from the following equation:

$$Q_s=\frac{\phi_1\cdot\phi_2}{\phi_1+\phi_2}\frac{\lambda_2}{\phi_2^2}\frac{T_0}{\sqrt{\pi\cdot t}}. \tag{15}$$

The density of heat flow dependent on temperature exposure can be expressed by the following equation [17]:

$$q_s=\frac{Q_s}{s^2}=\frac{\phi_1\cdot\phi_2}{\phi_1+\phi_2}\frac{\lambda_2}{\phi_2^2}\cdot\frac{T_0}{\sqrt{\pi\cdot t}}\cdot\frac{1}{s^2}, \tag{16}$$

where s^2 is the area of thermal influence, m^2.

Thus, we have built the dependences that make it possible to derive a value of the heat flow at the non-heated surface of the fabric protected with a swelling coating. These dependences provide an opportunity to directly calculate the value of the heat flow depending on the effect of high temperature.

5. 2. Results of determining the thermal conductivity of a fire-proof fabric sample under the action of radiation panel flame

To establish the thermal conductivity of the coating protected by fabric, the study was carried out on the transmission of heat under the action of the flame of the radiation panel to timber. The results of the study on heat transmission, performed under laboratory conditions, are shown in Fig. 4–6.

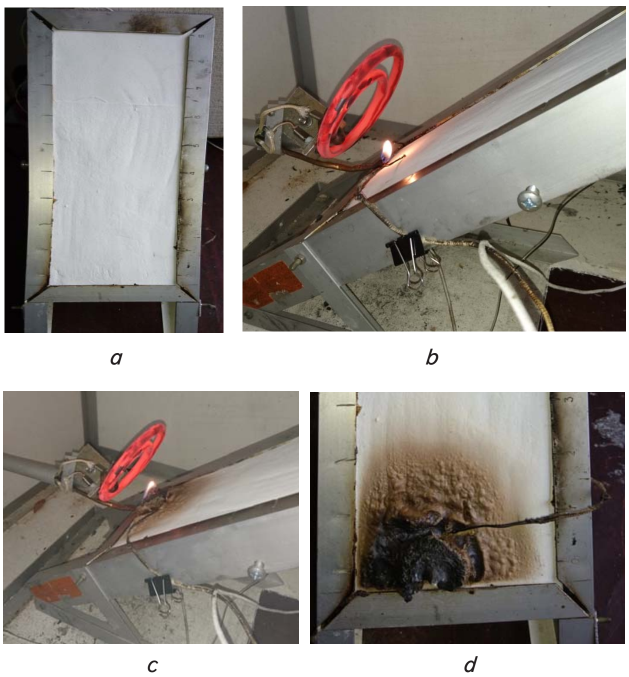

Fig. 4. Results of tests on the transmission of heat from the radiation panel through a protective screen made of fire-proof fabric: *a* — testing set-up; *b* — thermal action; *c* — swelling of the coating; *d* — heat-insulating layer of coked cellular material

Our study has shown that under the influence of the flame of the radiation panel, the surface of the fabric warmed up, which led to the formation of a layer of coked cellular material.

Under the action of the flame of the radiation panel, intensive heat transfer through a protective screen from fireproof fabric to the timber surface began, which led to the formation of a heat-protective layer of coked cellular material. In this case, no burning of timber occurred. The results of the study on determining the dynamics of temperature at the non-heated surface of the fabric carried out under laboratory conditions are shown in Fig. 6.

Our study has shown that the samples of the fire-proof fabric withstood a temperature exposure. Thus, under the action of the heat flow, intensive heat transmission took place, which exceeded the temperature of wood ignition and continued for 600 s. At the same time, the temperature at the non-heated surface of the fabric did not exceed the temperature of the ignition of wood.

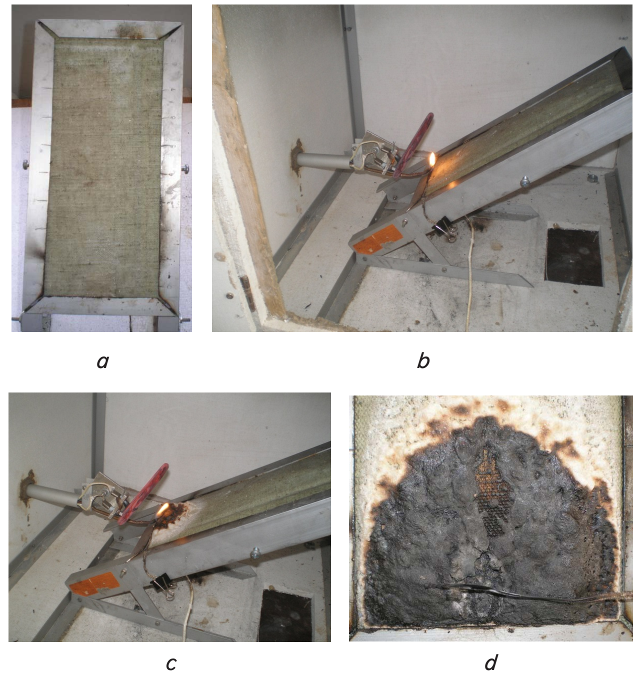

Fig. 5. Results of tests on the transmission of heat from the radiation panel through a protective screen made of fire-proof fabric: *a* — testing set-up; *b* — thermal action; *c* — swelling of the coating; *d* — heat-insulating layer of coked cellular material

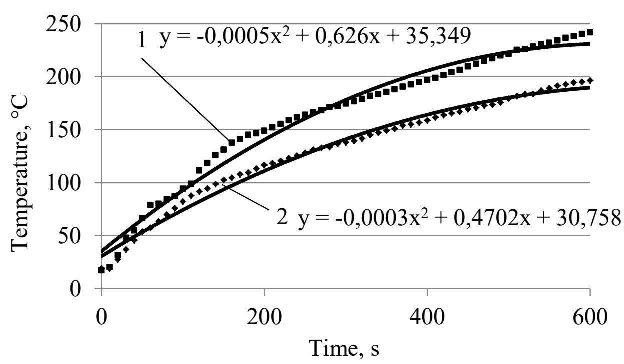

Fig. 6. The dynamics of temperature increase through a protective screen from the fire-proof fabric to the surface of timber for coating: 1 — based on "Firewall-Attic"; 2 — based on "Firewall-Wood"

A given method is limited only to determining the temperature at the surface of the wood depending on the action of the flame of the radiation panel; in this case, at the heat transfer through a protective screen of the fire-proof fabric, we registered the swelling of the coating that insulates the transmission of heat. Taking into consideration [12, 19, 20], the thermal-physical characteristics were determined for fabric, coked cellular material for the "Firewall-Attic" and "Firewall-Wood" coatings (Table 1).

The data in Table 1 show different thermal-physical characteristics of the materials, hence it follows that the thermal action through the wall of the coating would differ.

Fig. 7 demonstrates the calculation of the density of the heat flow q depending on the time of influence t on the fabric when the flame of the radiation panel is burning.

Table 1

Thermal-physical characteristics of materials

Indicator	Material name		
	Fabric [19]	Coked cellular material «Firewall-Wood» [12]	Coked cellular material «Firewall-Attic» [20]
coefficient of temperature conductivity, m/s^2	$16\cdot10^{-6}$	$0.26\cdot10^{-6}$	$0.31\cdot10^{-6}$
coefficient of thermal conductivity, W/(m·K)	0.078	0.45	0.034

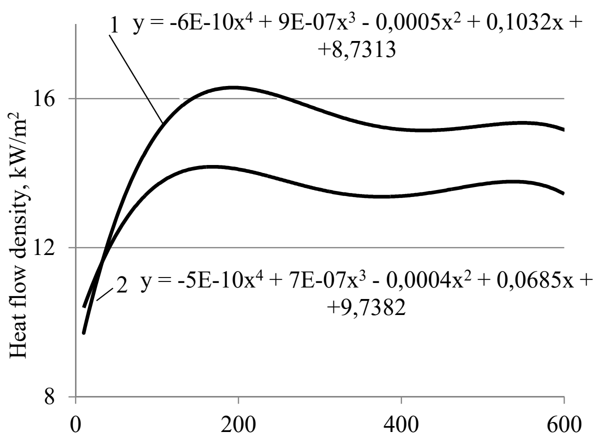

Fig. 7. Dependence of heat flow density on the time of action of the heating medium through a protective screen made of the fire-proof fabric for coating: 1 — based on "Firewall-Attic"; 2 — based on "Firewall-Wood"

Fig. 7 shows that with increasing temperature the density of the heat flow to the surface of timber through a protective screen made of the fire-proof fabric for a coating based on "Firewall-Attic" increases to a value above 16 kW/m^2. The resulting value is insufficient for the ignition of wood (the minimum value is 18.0 kW/m^2 [21]), and then gradually decreases due to the formation of a layer of coked cellular material on the surface of the fabric. Instead, the density of the heat flow through the protective screen of the fire-proof fabric protected by the "Firewall-Wood" coating did not exceed 14 kW/m^2.

6. Discussion of results of studying the process of formation of a layer of coked cellular material when the fabric is fireproof

When studying the process of protecting timber with fire-proof fabric, as it follows from our results (Fig. 4–6), it is natural to extend the time of temperature transfer through the fireproof fabric. This is due to the formation of a layer of swollen layer of coked cellular material on the surface of the fire-proof fabric when flame retardants decompose under the influence of flame, which slows down the processes of heat transfer to wood and its combustion.

It should be noted that the presence of a fireproof composition leads to the formation of an elastic film at the surface of the fabric, resistant to fluctuations in temperature and humidity. Such a mechanism of the influence exerted by an elastic film is likely the factor in regulating the process by which the fire resistance of the fabric is preserved. The results of determining the fabric's non-combustibility after exposure to the flame, namely heat transfer under the thermal influence should be interpreted in this sense since the temperature at the inverse surface of the sample was no more than 220 °C, which is not enough for timber to catch fire. This indicates the formation of a barrier for temperature, which can be identified using the method of thermal influence on the studied samples [21, 22].

That means that taking into consideration this fact opens the possibility for effective regulation of the properties of wood, coated with fire-proof fabric, directly at industrial production. The comparison of our experimental study on thermal insulation of wood, fire-protected with fabric, and the theoretical research into the thermal insulation of fabric indicates the inhibition of heat transfer processes. The reason for this is the fact that the temperature at the inverse surface under the action of the radiation panel did not exceed 220 °C.

This does not diverge from the practical data reported in [5, 6] whose authors also associate the effectiveness of fire protection with the formation of a layer of coked cellular material under the influence of a flame. However, unlike the results reported in [7, 9], our data on the effect of modified flame retardant compounds on the process of inhibition of temperature transfer make it possible to assert the following:

– the main regulator of the process is not so much the formation of a significant amount of gases that inhibit the flame but the fact that individual fireproof coatings are destroyed under the influence of high temperature;

– significant impact on the process of wood protection when using fireproof fabric is exerted towards the formation of a thermal insulation screen on the surface of wood, resistant to thermal destruction.

Such conclusions may be considered appropriate from a practical point of view because they make it possible to reasonably approach determining the required amount of a fireproof agent for fabric. From a theoretical point of view, this suggests defining the mechanism of temperature inhibiting processes, which are certain advantages of this study.

However, it is impossible not to note that the results shown in Fig. 6 indicate the ambiguous effect of the protective screen on the change of fireproof coating efficiency. This is manifested, first of all, by the temperature at the inverse surface of the sample when testing the "fireproof fabric wood" system. Such uncertainty imposes certain restrictions on the use of our results, which may be interpreted as the disadvantages of this study. The inability to remove these limitations within the framework of this study gives rise to a potentially interesting area of further research. In particular, it can focus on identifying the moment at which a drop in the fire-protective properties begins, followed by the ignition of wood under the influence of high temperature. Such a finding could make it possible to investigate the structural transformations of fireproof fabric that begin to occur at that time and to determine the input variables of the process that significantly affect the onset of such transformation.

7. Conclusions

1. We have modeled the thermal conductivity process involving a protective screen from fire-proof fabric under the

thermal effect on wood; the dependences were built to derive a change in the heat flow at the non-heated surface of the fabric. Based on the experimental data on determining the temperature at the non-heated surface of the fabric and the resulting dependences, we have determined the density of the heat flow transmitted to wood through the fire-proof fabric. Thus, with the increase in the temperature, the density of the heat flow to the surface of wood through a protective screen made of the fireproof fabric protected by a coating based on "Firewall-Attic" increases to a value above 16 kW/m^2, which is not sufficient for ignition of wood. Instead, the density of the heat flow through the protective screen of the fire-proof fabric protected by the "Firewall-Wood"-based coating did not exceed 14 kW/m^2.

2. Features of inhibition of the process of heat transfer to wood through a protective screen made of the fireproof fabric under the action of a radiation panel imply the formation of a heat-insulating layer of coked cellular material when the coating decomposes. Thus, at the surface of the fireproof fabric, a temperature exceeding 280 °C was achieved, while at the untreated surface of the fabric, it did not exceed 220 °C, which is insufficient for the ignition of wood.

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