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DEVELOPMENT OF TECHNOLOGY FOR OBTAINING FIREPROOF HEAT INSULATING MATERIALS BASED ON SILICATE-POLYMER COMPOSITIONS

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Abstract:
The research work presents the research results on the technology development for obtaining fireproof tile materials with effective heat insulation properties. The main components used to produce insulating tile materials were readily available raw materials such as standard natrium liquid glass, silicone, hydrochloric acid, epoxy resin, the mineral dolomite and wallastonite, thermovermiculite, as well as other special additives. Based on the work performed, the entire technological cycle of obtaining tile materials has been developed. In the work developed two types of tile material differing in the component composition. The first, tile material with a porous silicate composition and the second tile material, which is derived from, as the main component of thermovermiculite. The technological process weight of obtaining the two types of tile materials consists of several steps. At the first stage of research in the laboratory conditions developed compositions of these materials and then in the next few stages of research developed a full technological cycle of obtaining tile heat-insulating materials. Research samples of tile materials obtained by the developed technology showed that the samples of these materials meet the state standards requirements for physical-mechanical and fire-technical properties.

Keywords: Heat insulation material, ignitability, fire stability, fire hazard, sodium liquid glass, silicone, epoxy resin, dolomite, wallstonite, thermovermiculite

INTRODUCTION

As you know fire safety in construction is carried out by implementing a complex of construction, installation and other work, as well as organizational and technical measures to ensure fire prevention of buildings, structures and their complexes on the stages:design, construction, reconstruction, modernization, repair, technical reequipment. In this case under fire protection is understood a set of measures aimed at preventing the emergence, limiting the development and ensuring suppression of fire, as well as the protection of people and property from the effects of its hazards.[1-5].

Fire prevention of buildings is achieved by the use of structural, space planning and engineering solutions. These solutions can be divided into two blocks. The first, structural fire prevention, which establishes requirements for fire resistance and fire hazard of building structures and materials from which the building is made. The second, planning fire prevention, in which by means of space-planning solutions to ensure the implementation of fire prevention tasks[1-3].

Thus, based on the above it can be argued that, in order to adequately ensure the fire prevention of buildings, it is necessary in the construction of building materials with rated fire resistance and fire hazard.So, to achieve the necessary level of fire safety in buildings and structures is necessary to use materials that have the required fire performance characteristics[6].

Currently, one of the often used in the construction of modern buildings are heat insulation building materials, which in addition to effective heat insulation properties must be and fire safety[7-9].

METHODS AND MATERIALS.

This research work presents the results of research on the development of technology for obtaining tile porous and non-porous materials with effective heat insulation properties and the study of the obtained industrial batches of these materials of fire-technical characteristics.

Standard sodium liquid glass, silicone, cellulose diacetate (DAC), epoxy resin, sodium carboxymethylcellulose, urea-formaldehyde resin or their mixtures in various ratios were used as binder components to produce insulating tile materialsas well as finely ground dolomite, silica, the mineral wallastonite, thermovermiculites (TV) with various degrees of size.

It should be noted that for each particular material, the conditions of application and the optimal particle size of the main component or porosity must be calculated and tested by experience. As modern researches show, the interval of optimal values of particle sizes of one of the components (at which the thermal conductive properties of the composite itself are significantly reduced) is largely determined by the thermal conductivities of the materials of which the material consists, and their relative concentrations.In this case, the main component of the developed compositions is thermovermiculites with varying degrees of particle size with well-preserved porosity, which are obtained using the method developed by us. [10].

At the first stage of research the silicate compositions technology for the production of silicate tile materials was developed, which consists of the following stages and parts:

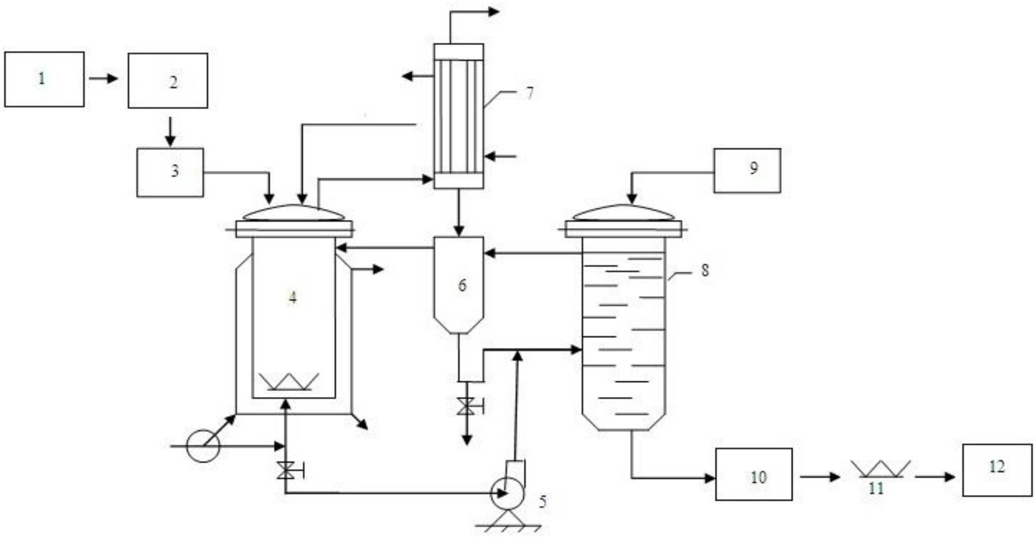

Figure 1. Basic technological scheme for producing a new heat insulating material

1. Crusher 2. Cleaning 3.Alkalinization 4. Reactor with electric stirrer (with jacket) 5. Water pump 6. Sump 7. Refrigerator 8. Neutralizer 9. Dispenser with pH meter 10. Furnace (1300^0C) 11. Dryer 12. Pressing and shaping.

According to the developed technology it will be possible to produce new compositions of porous materials, which by their thermophysical and fire-technical characteristics correspond to the requirements of state standards.Then, in the next stage of research, the installation for giving shape to the obtained silicate compositions was developed(Figure2.,3.and4.).

The process of obtaining silicate porous material includes the following stages. The first: in a reactor with an electric stirrer, a drop funnel and a thermometer, for 40 minutes to mix natrium liquid glass (1300-1500 kg/m^3) and dolomite in a mass ratio of 3:1.A 15% aqueous solution of hydrochloric acid is added dropwise through a dropping funnel, with constant stirring. (HCl). In this case there is a process of gas release. After adding the acid, the resulting mixture continues to mix until a homogeneous mixture is obtained. The medium solution will be weakly acidic (pH = 6,5 – 7,0). The resulting mass is poured into a special mold developed for this purpose, covered with foil from the inside(figures2,3,4,5). Then the form is heated to 4000^0C for 2 hours.Next, the resulting product is left in the open air to cool, since the product in the hot form tends to adsorb moisture. After cooling, the product is dried in a drying cabinet SS -80-01-SPU, at 1000^0C for 5 hours. The result is a gray product with high porosity. Product outlet is 61%.

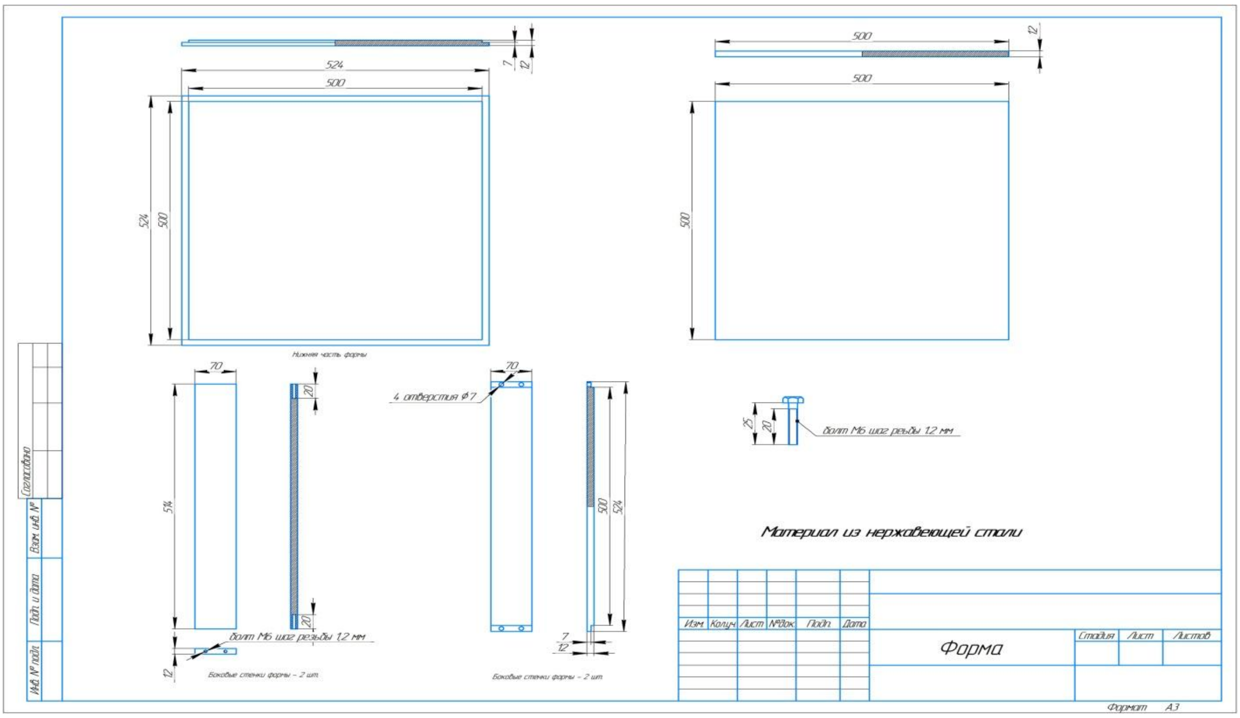

Figure 2. Drawing of the installation for the production of heat insulating tile materials.

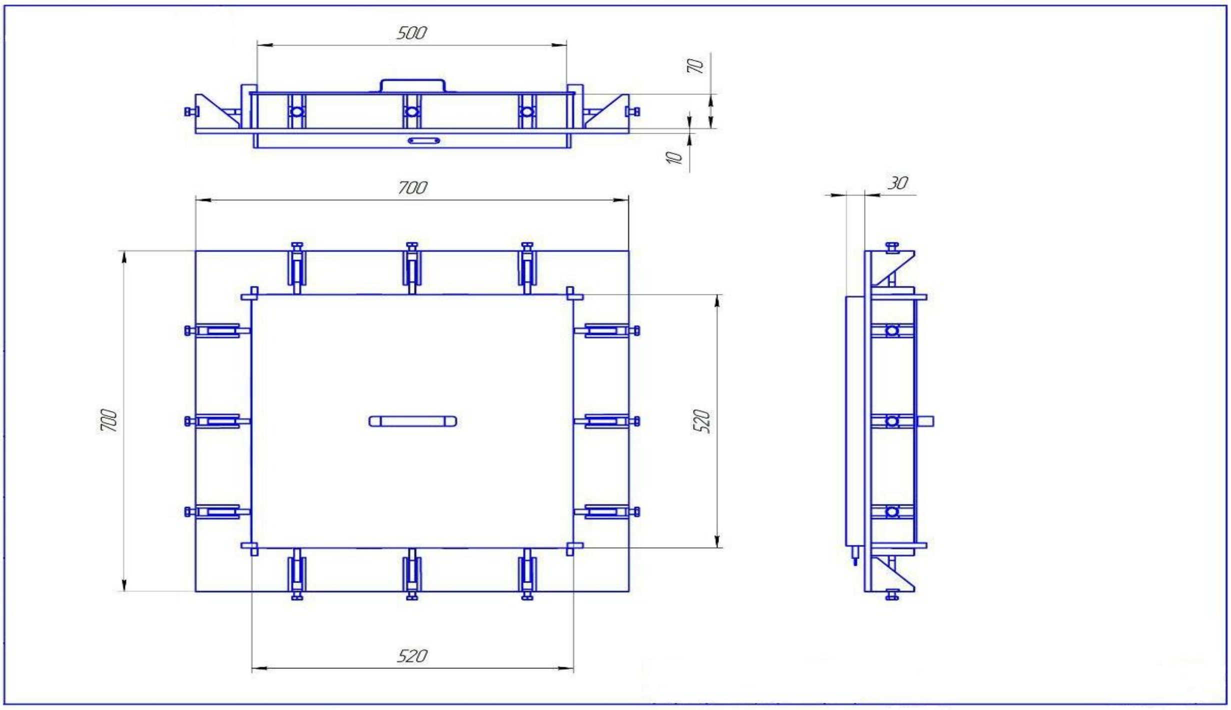

Figure 3. Drawing of the installation form for obtaining heat insulation

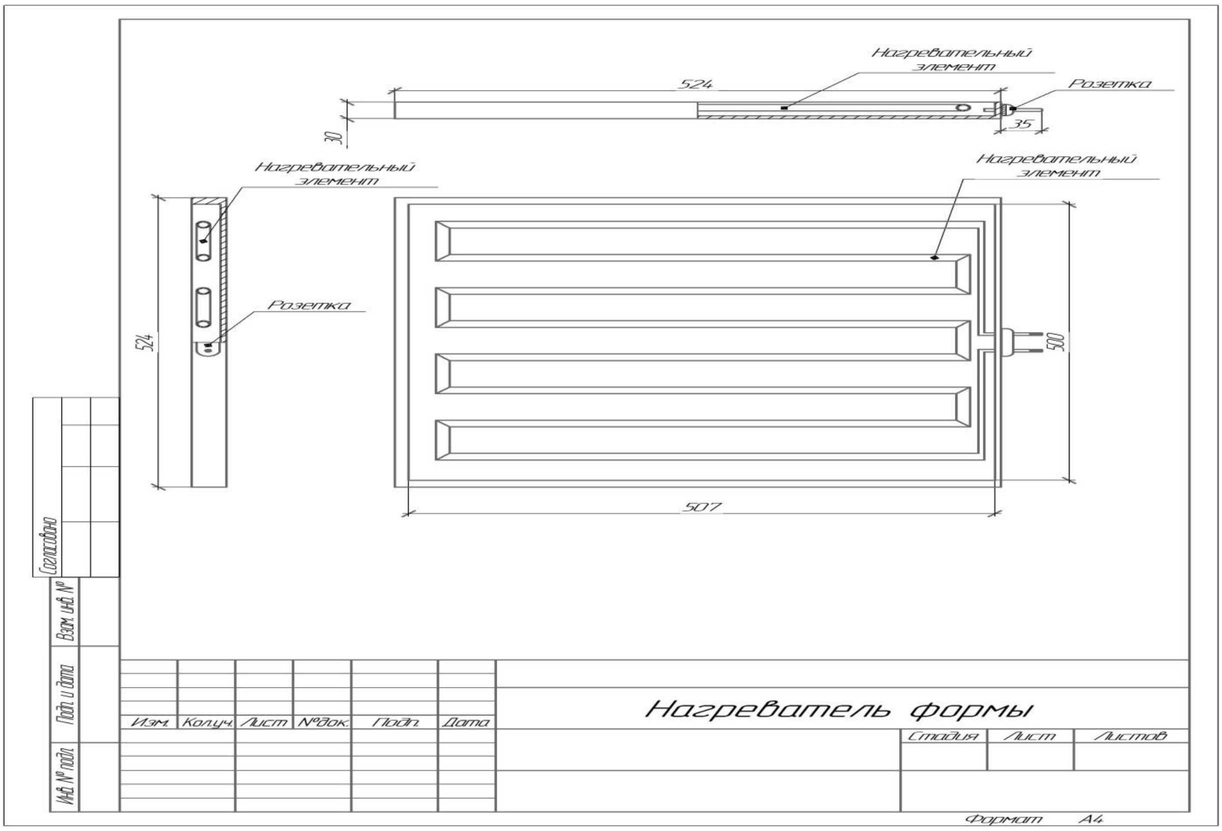

Figure4. The heating part of the installation for the production of tile heat insulating tile materials.

Figure 5. The process of obtaining silicate tile material.

Then, at the next stage of research, experiments were carried out to obtain with low values of thermal conductivity, water and moisture absorption as well as with the corresponding indicators of SS of physical and mechanical properties and high fire-resistant qualities of vermiculite heat insulating tile materials.

The process of obtaining samples of vermiculite tile materials was as follows:mixed calculated amounts of liquid glass, thermovermiculite and other additional components depending on the required characteristics of the resulting material. The resulting composition was mixed in a forced mixing machine. The resulting mass was then placed in a mold of the unit and heated to 100^0C. The heating time was 4 hours. This produced tile materials with dimensions of 50×50см.

Figure6. The process of obtaining experimental and industrial production batches of vermiculite tile materials.

Figure7. Samples of experimental-industrial vermiculite tile materials.

RESULTS AND DISCUSSION

Based on the experiments performed, solid and durable samples of tile materials were obtained. The fractions of thermovermiculite with a grain size of 3-4 mm were used. Thus, at this stage, the optimal grain size of thermovermiculite and the ratio of the main components for obtaining durable and fire-resistant tile materials were determined.

On the basis of the above technology were obtained tile materials using hydrophobic thermovermiculite and other available fillers such as glass fiber, basalt fiber, microcrystalline cellulose or their mixtures in different ratios (tables 1, 2 and 3.) and the results of their studies on the main fire-technical characteristics (table 4)

Table1

Compositions of tile materials based on thermovermiculite with different fillers

Number mixturecom posi-tion№	Content, mass ratios of components			
	Natriumliquidg lass(GOST170 58831-04:2000)	Termovermiculite(fractio n 3-4 mm)	Thinlydispersedwollast onite	Balsalticfiber
1	50	49	1	1
2	49	50	1	1
3	50	48	2	2
4	48	50	2	2
5	47,5	47,5	5	5
6	50	48	10	10

Table2.
Compositions of tile materials based on thermovermiculite with different fillers.

Num-ber mixturecomposition №	Content, mass ratios of components			
	Natriumliquidglass(GOST 17058831-04:2000)	Thermovermiculite (fraction 3-4 mm)	Thinlydispersedwollastonite	Microcrystalline cellulose
1	50	49	1	1
2	49	50	1	1
3	50	48	2	2
4	48	50	2	2
5	47,5	47,5	5	5
6	50	48	10	10

Table3.
Compositions of tile materials based on thermovermiculite with different fillers.

Num-bermixturecompositionBNNN№	Content, mass ratios of components.			
	LiquidGlass(GOST 17058831-04:2000)	Thermovermiculite (3-4 mm)	Thinlydispersed Wollastonite	Fiberglass
1	51,73	48,17	1	1
2	51,63	48,27	1	1
3	51,73	47,27	2	2
4	50,73	48,27	2	2
5	50,23	46,77	5	5
6	46,73	45,27	10	10

Then, at the next stage of research, the obtained samples of tile materials were examined to determine the indicators of basic fire-technical characteristics. Table 4 below summarizes some of the results of these researches.

Table4.
The main fire-technical properties of the resulting tile materials.

Com-posi-tion№	**Type of tile material**	**Flame spread (kW/m2)**	**Smokability (D)**	**Combustibi-lity**
1	Solidboard (poroussilicate)	non-distributive (РП1)	D1 Low smoke-forming ability	non-bitter
2	Vermiculite, solidboard	non-distributive (РП1)	D1 Low smoke-forming capacity	non-bitter
3	Vermiculite, solidboard	non-distributive (РП1)	D1 Low smoke-forming capacity	non-bitter
4	Vermiculite, solidboard	non-distributive (РП1)	D1 Low smoke-forming capacity	non-bitter

The measurements results (Table 4.) on the main fire-technical characteristics of the obtained materials show that they are not inferior in some respects compared to similar currently used materials.

CONCLUSION

Thus, on the basis of the conducted works the optimal composition recipe of silicate and vermiculite porous and non-porous structural heat insulating material with improved thermophysical, physical-mechanical and fire-technical properties corresponding to the requirements of SS is developed. Developed a full technological cycle of producing tile materials with effective heat insulation properties.

The use of the research results in the future allows to obtain fire-safe materials with effective thermal insulation properties, the use of which in the construction of modern buildings will increase their energy efficiency and fire safety.

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