The systems of insulation and a methodology for assessing the durability

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Abstract. Formation of effective insulation possible only taking into account features of the insulation layer in the construction and use of high quality materials, preserving their characteristics as in the early stages of operation, and for the entire billing period. The operational stability of the heat-insulating material is determined not only by its properties, but also the ability to withstand long-term operating loads without a significant change in properties. Processing load on the heater may be divided into three groups: the load during transportation and storage, loading and mounting load during operation. Methodology for assessing the properties of insulation products includes two main components: the installation for testing and test methods, as well as the methodology for assessing the operational stability. The methodology of the accelerated testing and forecasting durability tested for mineral wool products laminating, corrugating and volume-oriented structure. The test results give good agreement with the methods recommended by the building codes. Accelerated test plates on the compressibility and compressive strength at 10% deformation after exposure to boiling water over the useful spending for operational control properties of materials, as well as when examining the state of the exploited mineral wool insulation in buildings and heat piping

1 Introduction

Increasing gross domestic product energy efficiency in relation to the construction involves the improvement of design solutions (creating systems in which thermal insulation materials demonstrate their effectiveness to the greatest degree), as well as the creation and use of effective thermal insulation materials and methods of evaluation of their properties [1-4]. Energy efficiency in this case is the complex concept. Firstly, the insulating material must provide standard values of thermal resistance design. Second, the energy consumption

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for its production needs to be compensated by his "work" in the design (for the first ten heating seasons).

Thirdly, the material must save its properties (functional, structural, and dimensionally stable) at all times during the construction operation. Fourth, the exploitation is the material should not significantly increase the burden on the environment - the material must be fire safe and environmentally. Fifth, competently executed insulation helps create and maintain comfortable indoor conditions. The operational stability of the heat-insulating material is determined not only by its properties, but also the ability to withstand long-term operating loads without a significant change in properties. Processing load on the heater may be divided into three groups: the loads during transportation and storage, mounting and load during operation [5-6]. In the operation of the plate exposed to temperature, weather, humid and mechanical stress. The character of loads distribution in plates under various conditions of operation is shown in Fig. 1. Regardless of the type of building, system optimization parameter is the thermal resistance of the construction and parameter optimization of TIM is its thermal conductivity. At the same time the specificity of operation of TIM in each of the specific systems imposes certain additional insulation requirements - "restrictions", defined as "normalizing indicators".

2 Problem statement

Insulation boards operating in flat roof constructions, perceive the compressive load on the upper layers of roofing pie, temporary seasonal load and local small area load. The normalize indicator is a compressive strength at 10% deformation. Humidification insulation may in the result of violations of hydro-insulating roofing or "failure" vapor barrier, which is located on the ceiling.

If the roofing system reliably isolates the material from possible external fire exposure, application of EPS boards is real. In roofing systems using plates of foam glass and stone wool. Dual density plates are successfully proved his usage. The top layer takes a double density boards and transmits mechanical loads on the underlying layers, the lower layer - provides effective insulation and uniform adhesion of thermal insulation to the supporting elements. Thermal insulation in pitched roofs running in a "ventilated gap" conditions. Mechanical influences on it are minimal. Humidification heater perhaps for the same reasons as in the flat roof. The normalize indicator is breathable insulation. The use of combustible insulation is not allowed. In the case of mineral fiber materials (tiles, mats) needed windproof decision to exclude the removal of fiber products during erosion. In designs using glass products of such a fiberglass (glass veil), the application of products on the basis of basalt fiber - basalt canvas. In the application of stone wool products - dual density plates are recommended.

The designs of plaster facades are predominant is loads acting in the direction perpendicular to the plane of the insulation. The normalize indicator is the peel strength of the layers of insulation. It is imperative - vapor permeability of the insulation. Do not use EPS or foam glass plates, due to their low vapor permeability.

Allowed to use plates of PPP (or other combustible insulation) to the mandatory fire crosscuts at the height of ceilings and protective inserts on the perimeter of the openings (windows, doors). Optimal are mineral wool boards, including the boards of rock wool double density. Thick layer of dual density plates ensures a secure clutch of thermal insulation and plaster layer and the peel strength of the layers to the product itself.

Slabs of ventilated facades are characterized by three types of mechanical impact: compression under the load point, the gap layer (break down fibers), fiber erosion due to air flow in the material and vibration. Allowed use only non-flammable and vapor-permeable insulation. For wind protection possible to use non-combustible wind protection coating: canvases based on glass or basalt fibers, or use of dual density slabs of stone wool.

Insulation used in the protection of basements systems should be designed for mechanical stress, the penetration of condensed moisture and the possibility of migration of vapor. Normalizing parameters are strength at 10 % deformation, water resistance and water resistance. Insulation design is completely isolated from external fire exposure, so the optimal use of EPS or PIR plates.

3 Results and discussion

Experience has shown that the properties of materials, and, above all thermal insulation as having a low density and strength, change over time. A change more significant than the operating conditions are tougher. The analysis application possibilities insulation shown in various building systems, for most typical application of the thermal insulation on the basis of mineral fibers, so technique express evaluations, first of all, were tested for fibrous materials based on glass and rock wool, as well as basalt fiber.

The traditional criterion adopted humidity. Moisture mineral insulating material (MIM) in accordance with the GOST 17177 assessed by a decrease in their strength (compressibility) after exposure in the environment in the desiccator with a relative humidity of 96-100% and a temperature of 18-20 ° C for 3 days. To intensify this process was first suggested NIISF in the test sample in an environment of water vapor above the boiling water. MIM asked to be considered water-resistant if after 1 hour of testing strength reduction does not exceed 30 %.

The use of this technique not only significantly accelerated the evaluation of the water resistance of various MIM, but also allowed to accumulate practical information for potential improvements in techniques and design of the chamber to determine the moisture resistance MIM with horizontal and vertical orientation of the fibers in their structure. The data showed that between the values of strength reduction of samples-plates at their endurance over boiling water and store in a desiccator in moist air at 18-20 ° C there is a directly proportional relationship. Deeper study of this question showed that effect significantly affected by the type and degree of cure of the binder in the finished plates.

At the same time with a decrease in strength were observed signs of structuring of the uncured binder in the process of a long-term tests, as well as the permanent deformation of the low-density samples (35-70 kg / m^3) when removed from the camera after completing the tests and mounting in clamps of a discontinuous device. Strength reduction occurs at different rates, depending on the density of boards, the type of binders, the degree of cure and product structure [7-8].

With hard factory laboratory, monitoring of the degree of cure of the binder and the test this sample in the cells (Fig. 2 and 4) these disadvantages of the methods can be practically excluded. The camera in Fig. 2 is designed to determine the moisture resistance of samples of hard plates, increased rigidity and hard (by change the compression strength) after exposure of boiling water. The camera in Figure 4 is intended to determine the moisture resistance of soft and semi-rigid boards to change their compressibility after exposure over boiling water.

Camera (Figure 1) consists of unsealed vessel 1 with a lid 13 provided with a heat source 4 and a thermometer 12. Inside the vessel 1 is floating floating mesh tray 2 from the outside - pointers boiling water level 7 and its horizontality 5. During the test sample 10 set in a mesh container 9 and placed on the pallet 2, which to the rack 8 is attached to "floats" 3, providing a constant gap δ = 80-100 mm between the bottom and top of the sample of boiling water. To adjust the horizontal position of the device provided adjusting screws 6, for the convenience of removal cover of hot material 13 in its upper part placed handles 11. The gap between the top of the sample δ2 = 100-150 mm.

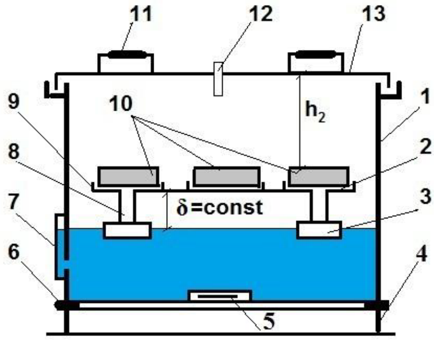

Fig. 1. Schematic diagram of the camera chamber design to determine the change in the compressive strength of mineral wool samples after their exposure over boiling water: 1 - the camera body 2 - floating mesh tray; 3 - floats; 4 - heater-element; 5 - the level of horizontality; 6 - the adjusting screws; 7 - water level indicator; 8 - racks; 9 - mesh container; 10 - prototypes; 11 - the handle; 12 - thermometer; 13 - upper removable cover.

Rapid method of humidity resistance studies is that instead of 3-10-day test sample in a desiccator at a temperature of (22 ± 5) ° C and humidity (98 ± 2) % produce their short term exposure (20 min.) In a water medium vapor at a temperature (98 ± 2) ° C and humidity (98 ± 2) %. Then, the test specimen under the accelerated procedure and build the calibration graph (Figure 3). On the axis of ordinates is strength value (A) or compressibility (A1) obtained by standard tests 3-10 days in a desiccator, and connect it till the intersection with the curve of 1 (2) obtained according to the accelerated tests in the medium of water vapor, and the axis x-value is obtained the required time of accelerated tests (respectively B or B1).

In the future (for example, when the daily trials and quality control boards at the factory), use once build the calibration graph for a particular product, determine the moisture only accelerated method, and compare it with the corresponding value of water resistance in the calibration curve. Change the water resistance may indicate a deterioration of the quality of binder, abuse of technology, etc.

With that, the experience of application of this method showed that the degree of MIM with phenol curing at least 90% over, the duration of exposure of samples upper of the boiling water should not exceed (20 ± 2) minutes. During this period, the temperature at which testing occurs (about 100 ° C) does not significantly affect the validity of the results. Therefore, during the factory laboratory and practical classes in middle and high schools of a building profile to determine the moisture resistance of MTM, you can set the duration of the exposure of boiling water in the range of (20 ± 2) minutes. [9-10].

A feature of the camera shown in Figure 4 is the possibility of it as a definition of the compressibility according to GOST 17177 and its changes after exposure of samples of boiling water without removing samples. To test sample 13 is placed on the lower mesh gasket 7, placed in the middle of the pallet rigid mesh 8. The distance between the bottom surface of the sample and the water surface is (100 ± 10) mm, and is controlled by the water level indicator 12. Then check the horizontality chamber 4 through a pointer 9, if necessary using the adjusting screws 11. On top of the sample 13 is laid mesh gasket 7 and the space frame 14. With the closing the lid 3, on which stationary secured elements of standard device for determining the compressibility by GOST 17177.

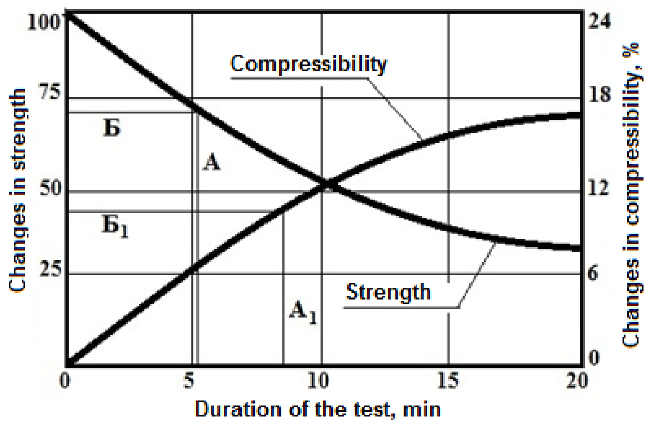

Fig. 2. The calibration curve for the determination of the duration of accelerated tests: 1, 2 - the curves of the changing accordingly compressive strength (σ) and compressibility (Cx) in an accelerated test; A and A1 - values of strength and compressibility after sorption moistening; B and B1 - time value of accelerated tests, the corresponding values of strength and compressibility, obtained after the moisture sorption.

At the start determine the compressibility of a sample 13 (Figure 2) under specific standard load, thus fixing its thickness h1. Then include source and regulator 10 heating the water, the water is brought to boiling by controlling the temperature and humidity by sensor 6 and the sample was kept in an environment of water vapor above the boiling water for a predetermined time: about (20 ± 2) minutes. Fix with the final sample thickness h_2. without removing it from the chamber.

When testing products on synthetic binders should be noted that the degree of hardening of the binder in these products shall be at least 90%. This condition corresponds to the requirements of the standard, according to which the fullness of condensation of synthetic binder should be at least 90 %. At a lower degree of polycondensation not excluded receive inaccurate data due to possible post-curing the binder at a test temperature of about 100 ° C.

The data obtained allow to recommend companies that manufacture MIM, replacing long 3-10 daily water resistance test sample plates by standard methods to express control. Accelerated testing may occasion the procedure (ex-press-technique) IISS (MGRS) in the design of cameras manufactured "MAXMIR".

4 Conclusion

The methodology of the accelerated test of products tested for the layered corrugated and volume-oriented structure. Accelerated test by plates on the compressibility and the compressive strength at 10% deformation after exposure of boiling water is useful to, in cases where the time of shipment party of plates the information about the relative change of their compressibility and strength after sorption humidification in desiccator is not obtained, and at operative factory quality control of manufactured boards (new middleware, the new components of the charge, changes in manufacturing and others. technology), and any disputes in their application, examination of the state of the layer of mineral wool insulation in buildings and heat piping exploited.

Properties of insulation which have arrived at the construction site may be different from embedded in the project. Therefore, to obtain an objective and timely information about the properties of the insulation material is a necessary factor in determining its suitability (or non-suitability, which is a force majeure), as well as the possibility of its using in this system with the permissible deviations from the project. The introduction of rapid methods for assessing the thermal insulation properties allows you to quickly appraise its properties. Information obtained as a result of the express control, of course, is accurate, but cannot be considered final. Full information can be obtained only by the results of laboratory tests based on existing standards.

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