Improving the Method of Testing Materials for the Heat Shield of the Building

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Abstract. Thermal protection of the walls is an essential factor in ensuring the quality of indoor air and energy conservation in the building. In the course of testing samples of materials for thermal insulation, a number of features were revealed that lead to a decrease in the quality of results and an increase in the cost of resources for testing. Taking into account the experience of the author suggested ways to improve the methodology.

1. Introduction
The installed capacity of heat supply systems and the actual energy consumption of buildings are significantly affected by the quality of thermal protection of its enclosing structures. In addition, the characteristic features of thermal protection have a direct impact on sanitary and hygienic parameters and the overall quality of the indoor air.

One of the most relevant technical solutions for the design of external walls is a multilayer wall with an effective insulation, a layer of external facing and an air gap. Mineral mats are used as insulation in such constructions. Characteristics of such materials may vary significantly in accordance with the plan laid down by the manufacturer of the material. And as a result of the features of the execution of this plan. A significant role in the effectiveness of thermal protection of such a wall is also played by the quality of installation and the use of various technical solutions to improve the entire structure [1, 2].

One of such solutions is the use of windproof membranes placed on the surface of mineral wool plates with periodic attachment to them or to elements of the bearing substructure. Also in a number of works the expediency of the device of gaps in the continuous surface of the cladding and the cutting of the air gap with a certain step along the facade height is discussed. The latter is offered mainly in order to protect against the spread of fire during a fire. Windproof membranes protect the surface of the fibrous material of thermal insulation plates from the weathering of fibers under the action of air movement in the air gap [3, 4].

Different approaches to the design of double hinged facades allow to obtain a number of sometimes opposite effects. Thus, a windproof membrane, allowing you to maintain the integrity of the material of thermal insulation, in some cases increases the risk of accelerated spread of fire in a fire [5]. This effect has long been known to manufacturers who are continuously working to improve the material from which this membrane is made. However, in addition, often not considered a phenomenon is the
reduction in the efficiency of the ablation of moisture from the surface of mineral wool when using membranes [6]. Thus, the main effect of the air gap device is reduced.

2. Method
The use of the membrane is decided by the designer and customer of the building independently, taking into account the recommendations of manufacturers and experts, but is not regulated by regulatory documents in an overwhelming number of countries. From the point of view of experts, the use of a membrane can be waived in the case of the use of fibrous insulation plates made on the basis of high-quality binder that prevents tearing and entrainment of fibres under the action of air flow in the air gap. To determine the quality of thermal insulation in Russia, a method of laboratory testing of the quality of fibrous insulation materials was developed and implemented for use as part of hinged facade systems.

An important feature of the operation of materials in the composition of building structures is a long stay in unfavourable conditions of the outdoor climate, significant differences in the magnitudes of all kinds of effects, intense mechanical effects from wind pressure. Thus, the prediction of the state of the material during its long-term operation implies either the use of test methods extremely long in time or the development and application of express methods.

For testing fibrous heat-insulating materials, a method of artificial accelerated building up by steaming the material and sequential application of 30 freezing and thawing cycles was proposed. Subsequently, the test specimens are placed in a test box, in which there is space for air movement above the surface of the material. The air in the allotted space moves at a speed many times higher than that in the air gap of the hinged facade system. This creates an effect of intensified effects on the test specimens. Its influence can be estimated by the results of comparative weighing of samples at regular intervals over the same 30 days [7]. The criterion of high quality of the material studied is considered to be the minimum decrease in its mass with the time of the test. Which indicates the minimum separation and ablation of fibres from its surface.

Given the many years of practice in conducting such tests in research laboratories in Russia [7], the state standard for conducting these tests was developed and approved (introduced from May 01, 2016, GOST R 56732-2015 “Materials and products of heat insulation. Methods for determining the emission characteristics of fibers when blowing air”). At present, this regulatory document establishes
uniform rules for all laboratories and groups of testers for the preparation and testing of test samples, designs and features of laboratory equipment.

![Graph showing sample weight change over time](image)

**Figure 2.** The dynamics of sample mass change over time under intense exposure.

![Sample images](image)

**Figure 3.** Samples to be rejected are detected without measurements.

3. **Results and discussions**

However, modern practice has revealed a number of factors that reduce the attractiveness of such a test method for both customers and researchers. It is necessary to recognize that the method proposed and approved in the standard, despite the ways used to intensify all types of effects, nevertheless remains
fairly long in time. With the most operational approach, none of the tests of the full cycle could be completed in less than 3 months. Thus, this test method cannot be attributed to the rapid methods.

Another important feature of the tests was high energy consumption for the drive of refrigeration and ventilation equipment, as well as high labour costs for maintenance personnel to carry out manipulations during defrosting or when weighing samples. All these features are known and allow to predict the need for time and resources when planning a study. However, with a large number of tests, another feature begins to manifest itself, associated with the rejection of a significant number of samples from one batch during each test. So, even for a well-manifested material, it may turn out that 1, 2 or even 3 samples from one batch show an anomalously large mass reduction in a very short test time. And from a certain moment the unsatisfactory state of the samples becomes visible without any measurements, only by visual assessment.

More careful attention to the registration of samples during the test revealed that those that were mainly rejected in various cells of the test box were rejected. And, probably, were not exposed to a characteristic effect. Including, during the extraction of samples from the installation for periodic weighing.

It should also be noted that the current test standard does not regulate the procedure for specific actions and requirements for individual manipulations with samples. Consequently, the same material studied in different laboratories or by different implementers can show itself in a significantly different way only because of different intensity and sequence of manipulations during the course of the study.

4. Conclusions
Thus, for the discussion of experts, the question of the need to make a number of improvements in the applied research method should be raised. At present, it is proposed to consider the possibility of rationing the number of samples placed simultaneously in the test chamber, the sequence and frequency of their rotation in the cells of the box. It is also proposed to think up changes in the design of the stand, which would allow to weigh the samples without removing them from the box. Or with the ability to carefully remove the samples along with the cell guide to determine the mass of the sample outside the test box.

At the same time, as a recommendation, testing laboratories can offer the use in the air supply system to the test box of guide vanes. This will make it possible to level the air flow over the surface of the test specimens and to ensure their placement in equivalent conditions. All these measures will improve the accuracy and quality of research to assess the stability of thermal insulation materials [8] to the effects of the environment in the conditions of double facades with an air gap.

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