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ТЕПЛОУСТОЙЧИВОЕ ИЗОЛЯЦИОННОЕ ПОКРЫТИЕ

В статье описаны результаты экспериментальных исследований по анализу и совершенствованию существующих методов определения теплопроводности жидких композиционных теплоизоляционных покрытий.

Ключевые слова: Энергоэффективность, теплоизоляционный материал, теплопроводность, микросфера, теплоизоляционная краска, стационарный метод, нестационарный метод, датчики термопар

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HEAT-RESISTANT INSULATING COATING

The article describes the results of experimental studies on the analysis and improvement of existing methods for determining the thermal conductivity of liquid composite heat-insulating coatings.

Key words: energy efficiency, thermal insulation material, thermal conductivity, microsphere, thermal insulation paint, stationary method, non-stationary method, thermocouple sensors

The issues of energy conservation and energy efficiency, including the construction and operation of buildings and structures, have become intertwined in the world today. This is the limitation of energy sources, the high cost of energy and is associated with a negative impact on the environment as a result of its production. Currently, the construction market offers a variety of thermal insulation materials. The currently available foam polystyrene, many new materials are being added to the range of mineral wool heaters designed for use in a variety of climates and construction conditions.

In recent years, thermal insulation paints based on hollow ceramics, glass and polymer microspheres have attracted a lot of attention.

These insulating paints have low thermal conductivity and excellent waterproofing after drying and is a high-tech composite material that forms an ultra-thin polymer coating that is resistant to anticorrosion (anti-slip).

Coating for thermal insulation, waterproofing, protection against erosion (corrosion) of heating and engineering networks, process pipes, thermal energy and capacity equipment and designed for thermal insulation and protection of facades and interiors of building structures, residential and industrial buildings.

This attention can be explained by the extremely low coefficient of thermal conductivity of these paints produced. For example, the coefficient of thermal conductivity of corundum brand paints 0,001Вт/м$\cdot^{0}$C [1], “Bronya” paint -0,001Вт/м$\cdot^{0}$C [2] is formed. Of course, such a thermal conductivity is similar to conventional heaters (extruded polystyrene foam, mineral wool, etc.) has a relative advantage over heat-insulating paints, hence the coefficient of thermal conductivity of extruded polystyrene foam is equal with 0,030 Вт/м$\cdot^{0}$C .

Therefore, the value of the thermal conductivity of liquid thermal insulation coatings in consumers is also has also aroused interest among researchers, as a result of which many experiments have been conducted to determine the thermal properties and effectiveness of these dyes.

The coefficient of thermal conductivity of air under normal conditions is 0,026 Вт/м·^{0}C, thermal conductivity of absolute vacuum 0 Вт/м·^{0}C [3]. Air is the best natural heat retainer [4].

The Tomsk State Institute of Architecture and Construction conducted an experiment on the method of GOST 7076-99 [5]. As a result of the work performed, the thermal conductivity of the two dyes was determined - 0,086 Вт/м·^{0}C ва 0,091 Вт/м·^{0}C. These results are much worse than the figures given by paint manufacturers. [4].

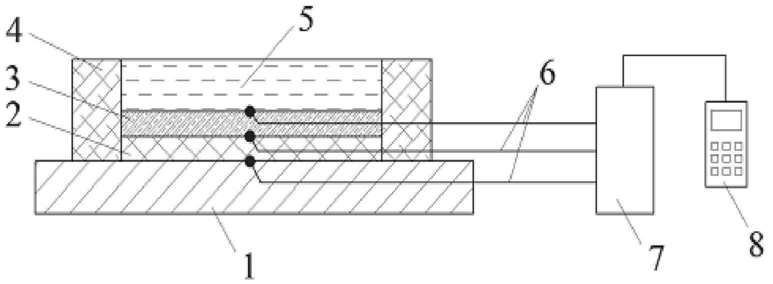
The thermal conductivity of corundum paint was determined according to TU 5760-001-83663241-2008 by the method M-001-2003 [6], developed by the Research Institute of the Federal State Unitary Enterprise “Plumbers”. The development of this method was due to the fact that ultra-thin liquid composite coatings based on glass, ayomosilicate, perlite and similar microspheres are not suitable for determining the thermal conductivity by stationary and nonstationary methods.[4,5].

Volgograd State University of Architecture and Construction was engaged in determining the thermal conductivity of corundum paint. The technical conclusion based on the test results includes methods for determining the thermal characteristics and the value of - 0,001 Вт/м·^{0}C is equal to the thermal conductivity of corundum paint [7].

The technical conclusion of NIIMosstroy, based on the results of thermal engineering tests in accordance with GOST 26254-84 [8], states that the value of the thermal conductivity of corundum-facade thermal insulation coating is 0,12 Вт/м·^{0}C and concluded that this material was unsuitable for thermal insulation of external walls [9]. A study conducted by the Siberian State Academy of Automobile Construction showed that the heat loss in a steel pipe coated with corundum paint is 20-30% less than in an unpainted pipe[10]. The discrepancies between the results obtained can be explained primarily by the lack of normative methods for determining the thermal conductivity of new ultra-thin coatings obtained on the basis of microspheres.The structure of all such paints consists of grids of hollow microspheres interconnected with acrylic film-forming substances. Therefore, determining the true thermal conductivity of liquid thermal insulation coatings is one of the urgent tasks at the present time.

The Youth Center for Innovative Technologies of the Fergana Polytechnic Institute is conducting research to improve the method of determining the thermal conductivity of ultra-thin thermal insulation coatings.

Based on the analysis of currently available methods in the development of the method, from the standard method of determining the thermal conductivity of liquid thermal insulation coatings [5] using a heat meter with a layer of material with a clear coefficient of thermal conductivity. Such a substitution does not contradict the theory of the study of thermal processes. [11].



1- Fig. Schematic of the equipment for determining the thermal conductivity of liquid thermal insulation coating.

1 stationary heat flow source; 2 is a layer of concrete material with a thickness and thermal conductivity (plexiglass δ=3,2 mm, λ=0,19 Вт/(м·°C); 3- thermal insulation coating layer; 4 heat insulator (foam); 5- “refrigerator” (water-filled capacity); 6- thickness σ = 0,2 mm. made of wire «chromel copel» thermocouples; 7-switch; 8-equipment for measuring thermocouple readings

Procedure for determining the thermal conductivity of thermal insulation coating:

The thermal conductivity of the liquid thermal insulation coating was calculated according to the following formula:

$$\lambda = \frac{d_u}{\frac{\Delta T_u}{q_u} - 2R_L} \quad (1)$$

Here d_u – thickness of the sample at the time of testing, m;

ΔT_u – the temperature difference at the surfaces of the test sample, ^oC;

q_u - the density of the stationary heat flux passing through the test sample, Вт/м^2;

R_L - the thermal resistance of the copper plate coated with the test sample (paint), (м^2·^{o}C)/Вт

The density of the stationary heat flux passing through the sample, qu, is given by the following formula:

$$q_u = \frac{\lambda_{2катлам}(t_1 - t_2)}{\delta_{2катлам}}, Вт / м^2 \quad (2)$$

here λ and δ – orgstekloni coefficient of thermal conductivity and thickness t_1, t_2 – the temperature at the boundaries of “heat source - orgsteklo layer” and “orgsteklo layer - test specimen”, respectively. Thickness δ = 0,5mm. the thermal conductivity of a copper plate λ = 384 Вт/(м·^{o}C)is equal with it.

During the study, the readings of the three thermocouple sensors were measured at intervals of 5 minutes for 0.5 h to “heat up” all its parts to stabilize the performance of the equipment and to stabilize the heat flow transmission. From the graph given in Figure 2, it can be seen that the equipment readings became stationary after 15 minutes.

To calculate the individual error of the thermocouple sensors, the temperature of each sensor immersed in a Dewar vessel filled with melted ice was measured before the start of the experiments, and the temperature deviation from 0 ° C was taken into account during the experiments.

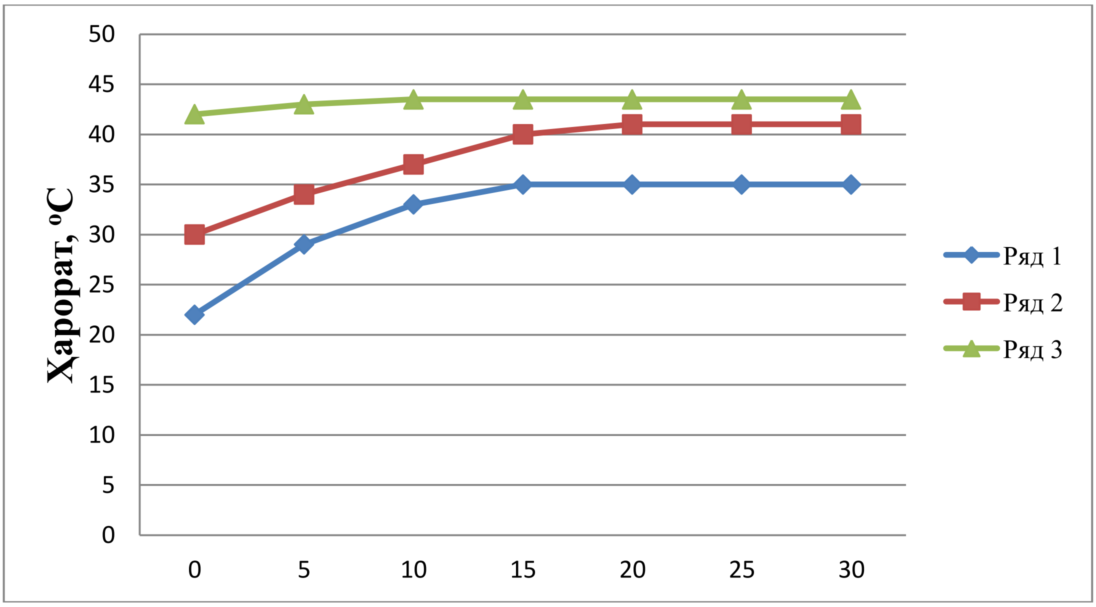
Initial tests were performed to determine the reliability of the thermal conductivity measuring equipment of the thermal insulation paint.

Instead of the 3rd layer in the device (Fig. 1), an orgsteklo plate similar to the 2nd layer in terms of size, thickness and thermal conductivity was placed and its thermal conductivity was measured.

The measurement results are the thermal conductivity of the tested orgsteklo plate λ=0,186 Вт/(м·°C) showed that In this case, the error of the method of determining the thermal conductivity:

$\Delta = \frac{0,19-0,186}{0,19} 100 = 2,1\%$

This error indicates that the error is not greater than the error given in GOST [5] (± 3%) and indicates the correctness of the selected study scheme.



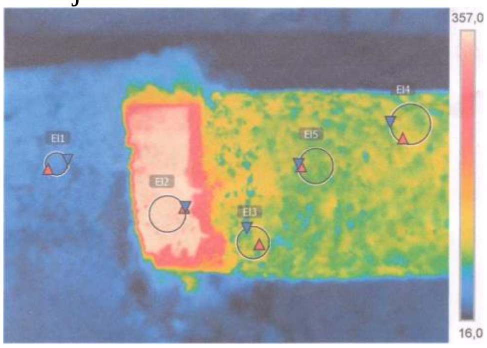
Time, minutes

2- picture. Indicators of the sensors of the three thermocouples of the equipment

In recent years, in the Fergana Polytechnic Institute in cooperation with the company "Ferganaazot" has created hollow microspheres and significant research has been conducted on liquid heat-resistant insulation coatings created using various binders (analog of our heat-saving coating).

The effectiveness of thin-layer thermal insulation coatings used in heat supply systems was determined, the technical and economic efficiency of the use of these coatings was evaluated.

The Center for Energy Saving Technologies is in the BAM workshop the effectiveness of the application of energy-saving coatings on the heating steam supply pipeline Д76 mm zadvijka to the station consumers was evaluated.



EI1	Max	77,6 °C
	Min	56,5 °C
EI2	Max	354,8 °C
	Min	326,2 °C
EI3	Max	159,7 °C
	Min	99,1 °C
EI4	Max	163,9 °C
	Min	126,5 °C
EI5	Max	152,4 °C
	Min	111,0 °C

3- Figure. Photo of paint coating

The inspection was outdoors. The coating is laid in 3 layers. The final thickness was 3 mm. Total coating consumption was 0.9 liters.

Data for calculation: Д pipe = 76mm.;

The wall = +410^{0}C (without insulation)

The wall - +18,4^{0}C (with coating)

F- the area of the valve surface = 0,3 м^2

For heat-insulated plots 1,58 Вт/м^{2}К

For non-heat insulated plots 12 Вт/м^{2}К

According to calculations, the heat loss from an uninsulated gate valve is 108.9 Kcal/ h, insulated - 9.13 Kcal/h.

The efficiency calculation showed that the coating allows to reduce the heat loss from the surface of the valve with a diameter of 76 mm from 108.9 to 9.13 (Kcal/h).

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