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CALCULATION METHODOLOGY BY THERMAL CONDUCTIVITY OF FOAM AND "POLYSTROBLOCK" OF THE MAIN CHARACTERISTIC.

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Abstract: This article provides detailed instructions on
the examination needed to be performed method of calculation by thermal conductivity of the foam and the main characteristic.

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The main characteristic thanks to which polystyrene foam has gained wide recognition as a material for insulation. This is the extremely low thermal conductivity of the foam. The relatively small strength of the material is compensated by such advantages.

- as resistance to the effects of most aggressive compounds
- small weight
- non-toxic
- work safety

The good thermal insulation properties of the foam plastic allow you to install insulation in the house at a relatively low cost. At the same time, the durability of such insulation is calculated for a service life of at least 25 years.

What should you know about the thermal conductivity of a foam plastic?

The material's ability to transfer heat, conduct, or retain heat flows is generally evaluated by the thermal conductivity coefficient. If we look at its dimension - W/m·Co, it becomes clear that this is a specific quantity, i.e., defined for the following conditions:

- The absence of moisture on the surface of the plate, that is, the thermal conductivity coefficient of the foam plastic from the reference book, is a value determined in perfectly dry conditions, which practically do not exist in nature, except in the desert or Antarctica;
- The value of the thermal conductivity coefficient is reduced to the thickness of the foam plastic of 1 meter, which is very convenient for theory, but somehow not impressive for practical calculations;
- The heat conductivity and heat transfer measurement results were performed for normal conditions at a temperature of 20^0C.

Calculation methodology

According to the simplified methodology, when calculating the thermal resistance of the foam insulation layer, the material thickness must be multiplied by the thermal conductivity coefficient, then multiplied or divided by several coefficients used to account for the actual operating conditions of the thermal insulation. For example, strong waterlogging of the material, or the presence of cold bridges, or a method of installation on building walls. How much the thermal conductivity of foam plastic differs from other materials can be seen in the comparative table below. To determine the value of thermal conductivity, you can compile it manually or use a ready-made program to calculate the insulation parameters. For a small object, this is usually

done. A private builder or self-developer may not be interested in the heat conductivity of the walls at all, but may lay insulation made of foam plastic material with a 50 mm reserve, which will be quite sufficient for the harshest winters.

Large construction companies that perform wall insulation on tens of thousands of square meters prefer to act more pragmatically. The completed calculation of the insulation thickness is used to compile the estimate, and the actual values of thermal conductivity are obtained at the physical object. For this, several different thicknesses of foam plastic are glued to a section of the wall and the actual thermal resistance of the insulator is measured. As a result, it is possible to calculate the optimal thickness of the foam plastic with an accuracy of several millimeters, instead of approximately 100 mm of insulation, it is possible to lay an accurate value of 80 mm and save.

How beneficial the use of foam plastic is compared to standard materials can be assessed from the diagram below.

What does the thermal conductivity of foam plastic depend on?

The thermal conductivity of foam, like any other material, depends on three main components:

- air temperature;
- density of the foam-plate slab;
- the humidity level of the environment in which the insulation is used.

As can be seen from the diagram, at low air temperatures, the gradient along the wall thickness changes linearly from negative values on the exterior surface of the facing to +20°C inside the room. It is necessary to choose the thermal conductivity and thickness of the material so that the dew point, or in other words, the temperature at which water vapor begins to condense, is located inside the foam plastic mass.

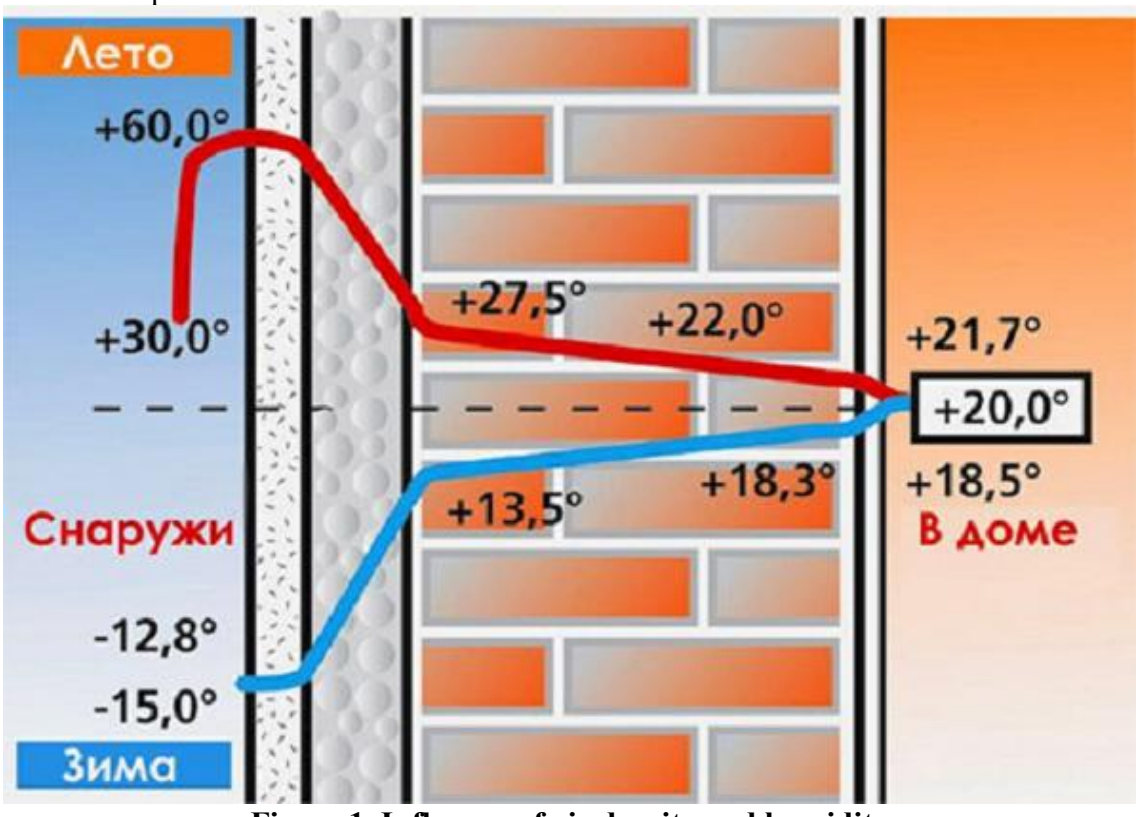

Figure 1. Influence of air density and humidity

Despite all the manufacturers' assurances, the foam plastic is capable of absorbing and passing water vapor. For comparison, the vapor permeability value for a foam plastic sheet is only 20% lower than that of wood. Naturally, the presence of water vapor in the foam film significantly affects its thermal conductivity. It is practically impossible to find the dependence in reference books, therefore, during calculations, an empirical correction for thermal conductivity is made based on the thickness of the thermal insulation.

Figure 2. Foam plastic used in facade walls for foam concrete, thickness 300 mm.

The foam plastic is capable of absorbing up to 3% water in the surface layers.

The absorption depth is 2 mm, therefore, when determining the material's thermal conductivity, these millimeters are discarded from the effective thickness of the thermal insulation. Therefore, a 10 mm thick foam plastic sheet will have a heat conductivity not 5 times, but 7 times greater than a 50 mm sheet. With a significant thickness of the foam, more than 80 mm, the resistance increases significantly faster than its thickness.

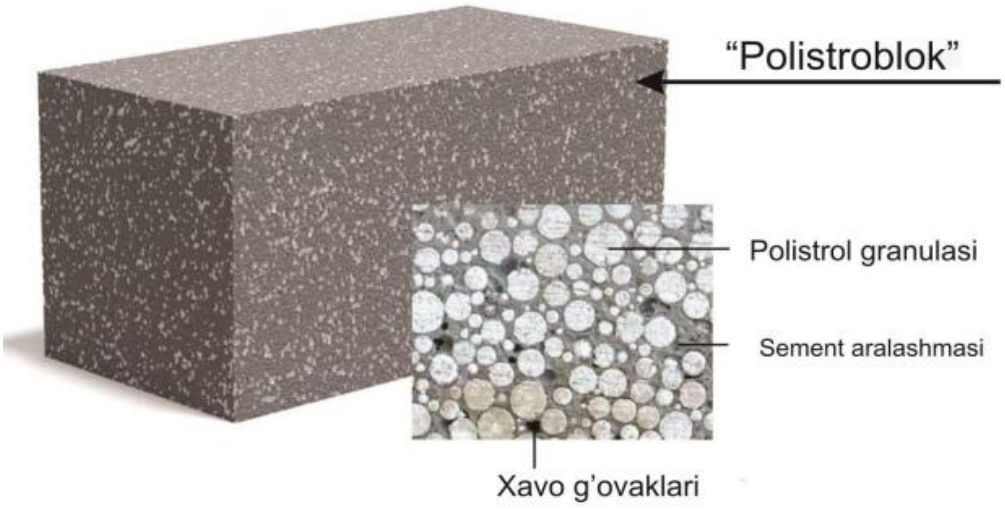

Figure 3. Polystroblock for facades.
Material density

Another factor influencing thermal conductivity is the density of the material. With the same thickness, a material of different grades can have twice as much density. It is generally accepted that 98% of the insulation structure consists of dried air. With an increase in the amount of polystyrene in the stove by half, naturally, the thermal conductivity also increases, approximately by 3%.

But it's not even about the amount of polystyrene, the size of the balls and cells that make up the foam plastic changes, and local areas with very high thermal conductivity or cold bridges are formed. This is especially true for cracks and joints, any deformation zones, and fastening installation. Therefore, when installing umbrella bushings, it is recommended to limit the number of fasteners to 3 points.

Influence of chemical composition on thermal conductivity.

Few people pay attention to the special properties of foam plastic. Today, the most serious problem with foam plastic is considered to be its ability to ignite and release toxic combustion products. For this purpose, salts of a number of non-ferrous metals such as chromium, nickel, and iron are used, including substances that release carbon dioxide when heated.

As a result, in practice, a penoplast with an index of "C" - self-extinguishing has significantly higher thermal conductivity compared to conventional polystyrene foam grades. The practice of using polystyrene foam for insulation in the European Union has shown that applying a special coating of gas-forming agents to the outer surface of unmodified foam plastic is more profitable and cheaper. This solution allows for the preservation of the material's heat-saving properties and environmental friendliness, while significantly improving fire safety.

conclusion

The thermal conductivity of the foam plastic practically does not change over time, as in mineral wool or gas silicate blocks. The only problem is the degradation of polystyrene foam under the influence of sunlight and scattered ultraviolet rays. With prolonged irradiation, the material becomes loose, covered with cracks, and easily filled with condensate, therefore, to maintain the initial value of thermal conductivity, the insulation must be covered with coating.

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