THERMAL INSULATION MATERIALS AND DETERMINATION OF THEIR OPTIMAL THICKNESS

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Abstract: Today, the operation of industrial enterprises depends on the efficient use of thermal energy. The main factor in the transfer of heat carriers is thermal insulation. Therefore, determining the heat loss in the transfer of heat carriers is an actual issue. Temperature modes of operation of heat-insulating structures are described in detail.

Key words: Heat-insulating materials, thermal conductivity coefficient, porous materials, foam plastic, expanded polystyrene, arbolite, DSP, DVP, mineral wool, glass wool.

The main source of energy saving is the reduction of energy consumption in the general housing sector. Today, energy consumption in this area is more than 80% of the total energy consumption in the construction industry.

Bringing the thermal technical properties of the objects to the level of modern European countries will improve the living conditions of the population. Research and analysis of articles conducted in this direction have shown the problems in this field. For example, if we talk about expanded polystyrene, its negative properties include its flammability, environmental hazard, and inability to work for a long time. Construction experience has shown that polystyrene foam installed on the wall loses its properties after 10-25 years. Similar thoughts can be said about mineral wool. After 7-9 years, they turn into dust, which is an environmental hazard. Therefore, the use of foam plastic and mineral wool in construction leads to the fact that after 7-10 years the barrier constructions cannot provide the required thermal resistance..

Along with the advantages of aerated concrete over other IIMs, there are also disadvantages. Due to high water absorption, resistance to moisture and cold is low. Due to its high hydrophobicity, the adhesion of the material to the surface is low and plastering becomes difficult.

Low strength, high density and insufficient heat insulation properties limit the scope of application of such materials.Ishdan maqsad zamonaviy IIM, ularning asosiy xossalari, qo‘llanish soxalarini tahlil qilish.

Taking into account the large number of types of IIMs, it is an urgent task to divide them into groups and develop materials with high efficiency.

Based on scientific research, rich experimental experiences have been collected and modern IIMs for buildings and structures have been developed.

Comparative analysis of IIM allows for the creation of new materials and effective optimization.

It is known that one of the main requirements for IIM is that the heat transfer coefficient (IO'K) of the material should be small and that it can be used for residential, production, agricultural building structures and various equipment and equipment (industrial furnaces, turbines, should be suitable for protection of pipes and x.k) surfaces.

The average density of such materials should be greater than 600 kg/m3. This is achieved by using porous materials. [1]

Thermal insulation in civil and transport construction makes it possible to reduce the thickness of barrier structures, and as a result, the consumption of basic building materials (brick, concrete, wood) is reduced, and the structure is lighter.

Heat insulation in technological and energy equipment reduces heat loss, provides the necessary technological regime, reduces fuel consumption.

Thermal calculations are performed based on engineering calculations in order to obtain sufficient efficiency as a result of the use of thermal insulation. Based on calculations, IIM with certain thermal-physical properties is selected. In recent years, dozens of new IIMs have appeared on the construction market of Uzbekistan. With the development of new technologies, modern IIM is becoming more efficient and environmentally safe. As a result, it is possible to build tall buildings, reduce the thickness of fence structures, reduce the weight of the building and the consumption of construction materials, and save fuel and energy resources.

In order to qualitatively classify IIMs, it is necessary to study their specific training characteristics and properties.

Organic IIM is made from natural raw materials: wood processing waste, agricultural waste, peat, various plastics, cement. [2]

Such materials are available in a wide range in the construction market. Almost all organic IIMs have low fire, water and biological resistance. Usually, organic heat insulators are used in places where the surface and ambient temperature does not exceed 1500 C and as the middle layer of multi-layer constructions.

Plastics filled with gas (foam, polystyrene, poroplast, sotoplast, etc.) are resistant to moisture, fire and biological agents.

Today, the share of porous plastics in the IIM market is increasing.

Such IIM is distinguished by its physical properties, low cost, ease of processing and long-term operation.

IIM made of arbolite has the following composition: portland cement, thin fiber components, liquid glass as mineralizers, aluminum sulfate, calcium chloride.

Arbolite is widely used in modern construction, its density is 500-700 kg/m3; IO'Q 0.08... 0.12 W/(m.K); compressive strength -0.5 ... 3.5 MPa; tensile strength -0.4, ... 1.0 MPa.

Polyvinyl chloride foam (PPVX) is made by foaming polyvinyl chloride resins. The average density of the material is 60...200 kg/m3. Polyvinyl chloride is divided into hard and soft groups, so it can be used for roofs, walls, floors and doors. Chipboard (DSP) organic fiber components (usually specially prepared chipboard) -90%; resin on a synthetic basis -7.9%; consists of hydrophobic elements, antiseptic, antiperspirant. Their density is -500 ... 1000 kg/m3; bending strength -10...25 MPa; humidity -5 ....12%; swelling in water-5.... 30%.

Wood fiber insulation boards (DVP) are made from wood waste: wood processing waste, waste paper, corn fiber, straw, synthetic resins and additives. Their density is -250 kg/m3; up to, bending strength up to -12 MPa, IO'Q up to -0.07 W/(m*K).

Foam polyurethanes (PPU) are obtained based on the chemical reaction of polyester, water, diisocyanide, emulsifiers and catalysts. Their density is 40... 80 kg/m3, IO'Q -0.019 ....0.28 W /(m*K)

PPU has high acoustic insulation properties and high chemical resistance.

Mipora is made on the basis of urea-formaldehyde resin, glycerin is added to reduce brittleness. The material contains petroleum sulfoacids (foam generators) and organic acids (catalyst). The density of the tower is 20... 80 kg/m3 (10 times smaller than the density of the plug), IO'Q -0.03 W/(m*K).

Mipora does not burn up to a temperature of 5000C. Due to its high porosity, water absorption is high.

Styrofoam (PPS) is 98% air and 2% polystyrene. PPS contains 0.3% of additives, such as flame retardant. IO'Q is equal to -0.037 .... 0.041 W /(m*K). Low flammability. The material is almost non-combustible. It is made of foaming polyethylene, hydrocarbons are added to create foam. Its density is 25 ... 50 kg/m3, IO'Q -0.044 ... 0.051 - 400 W/(m*K). It is used as a noise and vapor insulator in the temperature range from -400C to +1000C. Low water absorption, chemical and biological resistance.

Fibrolite is a tile material made from wood chips and portland cement. Material density -300 ... 500 kg/m3, IO'Q -0.08-0.1 W/(m*K).

Due to the presence of inorganic additives, fibrolite has high fire, biological and chemical resistance.

Based on the conducted scientific research, the following conclusions can be made about organic IIM:

- The material has low resistance to fire and water under the influence of loads;
- The material is highly toxic during fire.

Therefore, they can be used in places where people are not always present.

Inorganic IIM is presented in the market of building materials in an even wider range. Mineral raw materials are used for their production: rock, slag, glass, asbestos. Such IIMs include mineral and glass wool, lightweight concrete based on foamed perlite, cellular heat-insulating concrete, asbestos, ceramic materials, foam glass.

Among all IIMs, mineral wool is in the first place. Mineral wool from manufacturers such as Jsover, Jsoroc, Rockwool is widely available.

These materials are fire-resistant, do not rot, and have low hygroscopicity. They are also used to insulate building structures and surfaces of equipment and pipes. There are different types of mineral IIM. They are produced in the form of a roll, a solid plate.

We mainly consider the most common IIM mineral wool, glass wool, foam, porous concrete, silicates and others.

Depending on the raw material, mineral wool can be stony (basalt, dolomite, diabes, limestone) and slag (black and non-ferrous metallurgical slag).

Along with mineral raw materials, it contains phenol or urea resins. Phenolic binder fluff is widely used in construction. Because it is water resistant compared to wool with carbamide binder. Mineral wool is a non-combustible material. In addition, this material prevents the spread of fire. Therefore, it is used in fire protection and fire safety. [3]

Mineral wool is an effective acoustic insulation material. Its hygroscopicity is low and chemical resistance is high, due to the fact that the mineral wool settles (crushes) is extremely small, its geometric dimensions do not change.

Its main disadvantage is its high vapor permeability. Therefore, it is additionally insulated with a vapor barrier coating.

Products from glass polishing or glass industry waste are used to make glass wool. Glass wool fibers are thicker and longer than mineral wool. That is why glass wool has high durability and integrity. Material density is not greater than 130 kg/m3. IO'Q -0.030.....0.052 W/(m*K). , the temperature resistance is not greater than 4500C.

Glass wool is widely used as a sound insulator, resistant to aggressive environments and corrosion, does not emit toxic substances when exposed to fire.

Ceramic wool has higher heat resistance than mineral and glass wool, IO'Q - 0.13...0.16 W/(m*K) (at 6000C), density up to -350 kg/m3, high chemical resistance, resistant to various deformations.

Porous glass (porous glass) is produced in the form of blocks or plates. The average density of plates is 150...300 kg/m3, IO'Q 0.004...0.12 W/(m*K), compressive strength 1.0...3.0 MPa.

Products made of porous glass have high resistance to water, cold and temperature.

Porous concretes and silicates are used as IIM. Their average density is less than 400 kg/m3.

Depending on the method of creating pores and the type of binding material, IIM is called gas concrete, gas silicate, foam concrete, foam silicates.

Plates with a length of 1000 mm, width of 400, 500, 600 mm, thickness of 80, 240 mm are made from porous concrete, their average density is 350 and 400 kg/m3, the limit of compressive strength is at least 0.7 MPa. IO'Q is equal to 0.093...015 W/(m*K) at 250S.

Based on the analysis of IIMs considered above, the following conclusions can be made:

- all considered IIMs meet the requirements of QMQ "Thermal insulation of buildings";
- polyurethane foam, expanded polystyrene, mineral wool, foam polyethylene emit toxic gases. Their PDK is in demand;
- foam glass ranks first in terms of heat-technical, physico-mechanical and ecological safety indicators among all considered IIMs.

However, the development of such material is technologically complex and energy consumption is high.

Today, the operation of industrial enterprises depends on the efficient use of thermal energy. The main factor in the transfer of heat carriers is thermal insulation. Therefore, determining the heat loss in the transfer of heat carriers is an actual issue. Heat-insulating structures are divided into the following groups depending on the temperature regime of operation:

1. Structures with a surface temperature higher than the ambient temperature (over 200C);
2. Structures whose surface is below ambient temperature (190C and below);
3. Structures with sudden temperature changes (from positive temperature to negative temperature).

There are different ways to insulate pipes.

Heating with a heated cable is convenient and effective, because the pipe is kept from freezing throughout the winter months. Heating pipes with cables saves time and money.[4] There is almost no work on insulating uninsulated pipes or determining the optimal thickness of the insulation. The thickness of the thermal insulation can be determined depending on the density of the heat flux. The thickness of the insulation depends on the thermal conductivity coefficient (IO'K) of the heat-insulating material (IIM), heat carriers and ambient temperature, pipe diameter, pipe routing method, operating period. We determine the thickness of the IIM for the hot water supply pipe.

We calculate the thermal resistance for a cylindrical pipe according to the following formula:

$$R_1 d_{iz} = \frac{l_n(\frac{d_{iz}}{d_H})}{2\pi\chi_{iz} + \frac{1}{\alpha_\beta \cdot \pi \cdot d_{iz}}}$$

Here:

d_iz- outer diameter of IIM;

d_H-the outer diameter of the pipe;

IO'Q of ch_iz-IIM;

coefficient of heat transfer from a_b-IIM to air

Linear heat flux density:

$$q_1(d_{iz}) = \frac{t_H - t_{iz}}{R_1(d_{iz})}$$

Here:

t_H is the temperature of the outer surface of the pipe;

t_iz-IIM outer surface temperature

Internal surface temperature of IIM:

$$t_{sm} = t_n - \frac{q_1(d_{iz})}{\pi} \cdot \left(\frac{1}{\alpha_T \cdot d_\beta} + \frac{1}{2\chi_T} \cdot ln\frac{d_n}{d_\beta}\right) \qquad [3]$$

here: $d\_b - the\ inner\ diameter\ of\ the\ pipe;$

$a\_T - coefficient\ of\ heat\ transfer\ from\ the\ liquid\ to\ the\ wall;$

$ч\_T - IO'K\ of\ pipe\ material$

$We\ make\ a\ heat\ balance:$

$$2.75\frac{d_n \cdot \chi_{iz}^{1.35} \cdot t_H^{1.73}}{q_1(d_{iz})^{1.5}} - \frac{d_H \cdot 2.75\frac{d_n \cdot \chi_{iz}^{1.35} \cdot t_H^{1.73}}{q_1(d_{iz})^{1.5}}}{2} = 0$$

The diameter of the IIM (d_iz) can be determined using the above formula.[5]

Then the thickness of pipe insulation is calculated:

$$\delta = \frac{d_{iz} - d_H}{2}, \qquad m;$$

There is an optimal thickness of IIM. If it is greater than this thickness, the IIM will not give an additional effect, resulting in excessive consumption. [6] Taking into account the simplified option, the optimal thickness of IIM can be calculated from the following formula:

$$\delta_{onm} = \left(\frac{10^{-3} \cdot C_y \cdot \tau \cdot N \cdot \Delta t \cdot \chi}{S_{yT}}\right)^{0.5} \qquad (4)$$

Here:

C_y - the price of heat received from the source;

τ- Working time of IIM in a year, hours;

Δt - Temperature difference;

S,t- surface and thickness of IIM;

N- Normative working time of IIM, year;

χ -IO‘K.

Conclusion.

The article analyzes modern thermal insulating materials, their properties, areas of application. A method for determining the optimal thickness of the insulation has been developed. On the basis of scientific research, b experimental experiments were assembled and modern Times for buildings and structures were developed. Comparative analysis of IIM allows you to create and efficiently optimize new materials.

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