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Studying the Properties of Modern Thermal Insulation Materials

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Abstract. Particular attention deserves the heat-insulating material - foam glass, which is an artificial silicate material with evenly spaced pores (0.1 ... 5.0 mm), separated by thin partitions of vitreous substance, has the necessary properties and, due to the foregoing, can be accepted for research aimed at its improvement (modification). The research results can be applied in the production of foam glass, which is used for thermal insulation of buildings and structures, equipment, pipelines, etc.

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Introduction:

The primary source of energy savings is the reduction of energy consumption by public housing facilities, whose share of the construction industry's total consumption is greater than 80 percent. In addition to conserving energy resources, bringing the thermal properties of objects up to modern European standards will solve the problem of ensuring a standard level of comfort in the living environment, the absence of which has become a significant social issue for residents of multi-unit residential buildings and employees of social institutions.

Low thermal conductivity and suitability for thermal insulation of building structures of residential, industrial and agricultural buildings, surfaces of industrial equipment and units (industrial furnaces, turbines, pipelines, refrigerator chambers, etc.) are known to be the primary requirements for heat-insulating materials. The average density of these materials should not exceed 600 kg/m3, which can be attained by increasing their porosity [3].

Organic thermal insulation materials are derived from natural raw materials, including woodworking and agricultural detritus, biomass, and various plastics and cement.

This is a relatively large group of materials offered in a wide variety on the market. The majority of organic heat insulators have low fire, water, and bioresistance. Organic heat insulators are typically utilised in areas where surface and ambient temperatures do not exceed 150 degrees Fahrenheit, as well as in the intermediate layer of multilayer structures, such as gypsum facades, wall cladding, triple panels, etc.

Wood-concrete products consist of the following ingredients: As a mineralizer, Portland cement, fine-fiber components (sawdust, cut straw and grasses, wood chipping, and shavings), and chemical additives (soluble glass, alumina sulphate, and calcium chloride) are utilised. Wood

concrete, with a density of 500 to 700 kg/m3, has a thermal conductivity of 0.08 to 0.12 W/(mK), a compressive strength of 0.5 to 3.5 MPa, and a bending tensile strength of 0.4 to 1.0 MPa.

By porosifying polyvinyl chloride polymers, polyvinyl chloride foam (PVC) is produced. The average material density is 60 to 200 kilogrammes per cubic metre. Differentiate between firm and flexible polyvinyl chloride, which permits its use as a heat-insulating material, as well as for doors, facades, walls, floors, and roofs.

Chipboards (chipboards) are composed of organic fibrous components (in most cases, wood fragments are processed in a special manner) - 90 percent; synthetic polymers - 7 to 9 percent; water-repellent substances, antiseptics, and flame retardants. Their density is 500–1,000 kg/m3; their bending strength is at least 10–25 MPa; their relative humidity is 5–12%; and their expansion in water is 5–30%.

Wood fibre insulation boards (MDF) are made from waste wood: woodworking and sawmill waste, waste paper, corn stalks, straw; as binders: synthetic resins and chemical additives (water repellents, fire retardants, antiseptics); density - up to 250 kg / m3; bending strength - up to 12 MPa; thermal conductivity - up to 0.07 W / (mK).

Polyurethane foams (PPU) are produced through a chemical reaction involving polyester, water, disocyanide, emulsifiers, and catalysts with densities ranging from 40 to 80 kg/m3 (PPU with densities above 50 kg/m3 also acquire waterproofing properties). The thermal conductivity of PPUs ranges from -0.019 to 0.028 W/mK. In addition to their resistance to heat and water, polyurethane foams have excellent acoustic insulation and chemical resistance. They are employed for sawn thermal insulation, allowing for the waterproofing and insulation of structures of any complexity while preventing the formation of "cold bridges."

Mipora is produced by foaming an aqueous urea-formaldehyde resin emulsion to which glycerin has been added to reduce brittleness. In addition to petroleum sulfonic acids (as a foaming agent) and organic acids (as a catalyst), this material also contains organic acids. Mipora can be supplied as blocks, slabs, or fragments, or it can be poured into structures and cavities, where it will solidify at room temperature. Its density is less than 20 kg/m3 (approximately ten times less than that of cork), and its thermal conductivity is 0.03 W/(mK). Mipora does not burn at temperatures as high as 500 degrees Celsius, but instead chars. In addition, a flame retardant is added to the mipore's composition to prevent it from igniting in an oxygen environment. Mypora is sensitive to chemical aggression. Due to its high porosity, it absorbs a considerable amount of water.

Through a series of steps, expanded **polystyrene (EPS)** is a foam composed of 98% air and 2% polystyrene derived from petroleum. In addition, a small quantity of various modifiers, such as a flame retardant, are added to the expanded polystyrene composition. Its thermal conductivity ranges from 0.037 to 0.041 W/(mK), and its low hygroscopicity determines its excellent waterproofing qualities. It is resistant to corrosion, does not promote the growth of microflora, and is not susceptible to the action of bioagents - it has low flammability. This material is self-extinguishing: the quantity of thermal energy emitted by polystyrene foam during combustion is seven times less than that of wood blue.

Foamed polyethylene is created by adding hydrocarbons as a foaming agent to polyethylene. It has a density between 25 and 50 kg/m3 and a thermal conductivity between -0.044 and 0.051 W/mK. It is used as a noise and vapour barrier at temperatures between -40 and +100 degrees Celsius, has low water absorption, and is chemically and biologically resistant.

Fiberboard is a tile material composed of thin, narrow wood particles (wood fibre) and an inorganic binder component (typically Portland cement, but occasionally magnesia). Thermal conductivity ranges from 0.08 to 0.1 W/(mK) at densities of 300 to 500 kg/m3 and 300 to 500 kg/m3 respectively. Inorganic compounds increase the fire resistance, biological resistance, and chemical resistance of fiberboard. Can be used in high-humidity conditions, such as for the remediation of spaces around swimming pools.

Conclusions

After analysing the thermal performance of various thermal insulation materials on the Ukrainian market, it can be concluded that they all meet the requirements of 2.6-31:2006 "Thermal insulation of buildings"; however, the following should be clarified: polyurethane foam, expanded polystyrene, extruded polystyrene foam, mineral wool and products, and polyethylene foam emit toxic substances, the concentration of which does not exceed the MPC, but has cumulative properties, which are considered to Foam glass is the most optimal material in terms of thermal engineering, operational and physical and mechanical properties, as well as environmental safety and manufacturability. In order to reduce the cost of this material without sacrificing its physical and mechanical properties, its production necessitates modification and optimisation of compositions, as well as advancements in production technology.

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