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Thermal Insulation Materials and Their Features Applications

Tilovqobilov Nodirbek Nuriddin o'g'li
master student of Samarkand State Architectural and Civil Engineering University

Karimov Gofur
PhD of Samarkand State Architectural and Civil Engineering University

Abstract. *Increasing energy efficiency and conserving energy are the current focal points of Russia's energy policy. In this regard, the current market for construction materials offers a vast array of heat-insulating materials of various varieties and manufacturers.*

Their diversity can sometimes lead the consumer down a dead end. Each material's manufacturer touts the material's benefits in its advertising materials, ignoring the material's other characteristics that render its use insufficiently effective or, in some cases, simply inadmissible under certain conditions.

This article describes the fundamental principles of comparing materials, enabling the consumer to select the most suitable option for him based on the most important characteristics. The primary categories of heat-insulating materials are examined. As a result of the market analysis, a methodology has been devised that, presented in the form of a table, optimises the selection of a specific product based on a broad set of criteria.

Keywords:
thermal insulation materials, energy efficiency, comparative characteristics, thermal protection of buildings, coefficient of thermal conductivity;

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Introduction:

Increasing energy efficiency and conserving energy are the current focal points of Uzbekistan's energy policy. The 2019 law fosters the dynamic expansion of both imported and domestic thermal insulation materials on the construction market. Numerous investigations [1–7] proved conclusively that when

When designing an energy-efficient home, preventing heat loss through building envelopes should take precedence over optimising the work of building engineering systems, reducing lighting costs, and incorporating alternative energy sources.

Thermal insulation materials, the primary characteristic of which is thermal conductivity, play a crucial role in ensuring optimal interior climate conditions.

The effectiveness of a particular type of material depends on the following factors: - the energy intensity of manufacturing a material with regulatory properties; - the operational stability of the

material in specific operating conditions; the energy intensity of construction works (installation of the material in the structure); and the reduction in the cost of space heating [8].

In accordance with standart of DAST 23-02-2003 [9], when selecting a material for thermal insulation, temperature and humidity conditions, loads and deformation effects on the structure, operating conditions, and other requirements must be considered in addition to heat transfer resistance.

Such requirements may include permeability, water resistance, and fire resistance. In addition, it is essential that the material retains its operational stability throughout its entire service life.

It is extremely difficult to determine how a heat-insulating material functions in a structure because the material is typically located within the structure. The deterioration of a material's insulating properties [10] is caused by a change in the material's geometric characteristics over time. Therefore, materials with a more dense exterior and less dense interior are preferred. The layered structure prevents or reduces moisture penetration into the material, reduces air filtration through the insulation layer, and reduces the danger of material erosion by filtration fluxes [8]. Frequently, it is necessary to utilise materials with relatively high strength while retaining insulation effectiveness [11]. Every enclosure provides resistance to heat transfer. To achieve significant heat resistance, the enclosing structure must be of considerable thickness; however, this is not economically feasible. Consequently, the reduction in the cost of heating the room is accomplished by employing the most energy-efficient and cost-effective thermal insulation material [12].

Methodology

Consider the main groups of heat-insulating materials, their main properties and characteristics that distinguish them from other materials.

Mineral wool is a fibrous material having a wool structure and made from a rock melt with the addition of an organic binder component.

- Thermal conductivity coefficient - 0.038-0.045 W / (m K); - Density (hardness) - 35-165 kg / m³;
- Combustibility (fire safety) - NG;
-High chemical resistance;
-Good vapor permeability

Glass wool is a glass staple fiber made from glass industry waste with a high proportion of organic binders.

- Thermal conductivity coefficient - 0.037-0.046 W / (m K); - Density (hardness) - 13-84 kg / m³;
- Combustibility (fire safety) - G1-G4;
-High chemical resistance;
-High water absorption.

Expanded polystyrene foam is a rigid material, mainly with a cellular structure, obtained by sintering polystyrene granules or one of its copolymers.

- Thermal conductivity coefficient - 0.03-0.045 W / (m K);
- Density (hardness) - 15-41 kg / m³;
- Combustibility (fire safety) - G4;
-Non-hygroscopic;
-Low compressive strength.

Extruded polystyrene foam is a rigid material with a closed cell structure, obtained by extrusion of expandable polystyrene or one of its copolymers.

- Thermal conductivity coefficient - 0.038-0.041 W / (m K);
- Density (hardness) - 25-43 kg / m³;
- Combustibility (fire safety) - G2-G4;
- Waterproof;
-High compressive strength.

Polyurethane foam is a rigid or semi-rigid material with a closed cell structure. Can be applied as rigid panels or liquid mixtures.

- Thermal conductivity coefficient - 0.03-0.05 W / (m K);
- Density (hardness) - 30-210 kg / m³;
- Combustibility (fire safety) - G2-G4;
-High chemical and biological stability;
-Needs protection from sunlight; K-FLEX is a closed cell synthetic rubber foam material.
- Thermal conductivity coefficient - 0.03 W / (m K);
- Density (rigidity) - 41 kg/m³;
- Combustibility (fire safety) - G4;
-Effective in isolation from very high or very low temperatures;
-Additional soundproofing properties.

Isollat is a liquid viscous suspension that forms a durable polymer coating on the surface. Consists of ceramic microspheres with rarefied air and acrylic binder.

- Thermal conductivity coefficient - 0.005 W / (m K);
- Density (rigidity) - 410 kg/m³;
- Combustibility (fire safety) - NG;
-Waterproof;
-Adhesion (adhesion to coated surfaces).

Airgel is a material that is a gel in which the liquid phase is completely replaced by a gaseous one.

- Thermal conductivity coefficient - 0.021 W / (m K);
- Density (rigidity) - 185 kg/m³;
- Combustibility (fire safety) - NG;
- Waterproof;
- Vapor permeability;
-High strength;
- Insulation against very high temperatures.

To solve the problem of a comprehensive comparison of types of heaters, it is proposed to summarize the main indicators in a table, defining in it the most common groups of materials and comparison parameters. The consumer will be able to simultaneously evaluate all the main characteristics of various groups of materials, arrange the comparison parameters in the order he needs in order of priority. Then, after choosing the type of material, clarify its specific characteristics within the group. Using it, you can objectively weigh the advantages and disadvantages of each of them, which is almost impossible to do by personally contacting specific numerous manufacturers.

Conclusion

As a result of analysing the market for thermal insulation materials, a methodology was developed that optimises the selection of a particular product based on a broad set of criteria. Its use substantially reduces the labour required for the consumer to select one material over another.

The technique's simplicity is accomplished through the use of a tabular format. Due to this, it can be utilised for private purposes by both seasoned construction professionals and ordinary consumers.

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