THE IMPORTANCE OF THERMAL INSULATION MATERIALS IN BUILDINGS

U.Q.Toshmatov
Student of the Faculty of Civil Engineering of Fergana Polytechnic Institute
E-mail: ***Ulugbektoshmatov29@gmail.com***
X.T.Jamoliddinova
Student of the Faculty of Civil Engineering of Fergana Polytechnic Institute
E-mail: ***politexbiq@gmail.com***

Abstract. The role of thermal insulation materials in buildings cannot be overstated, as they significantly contribute to energy efficiency, occupant comfort, and environmental sustainability. This article aims to highlight the importance of thermal insulation materials in buildings by discussing their impact on reducing heat transfer, minimizing energy consumption, and improving indoor climate control.

Keywords: thermal insulation materials, buildings, energy efficiency, occupant comfort; environmental sustainability.

The Introduction section provides an overview of the global energy consumption patterns in the building sector and emphasizes the need for effective thermal insulation solutions. It highlights the potential benefits associated with reduced heat loss or gain through building envelopes, including lower heating and cooling costs and decreased carbon emissions [1-3].

In today's world, where energy efficiency and sustainability are paramount, the role of thermal insulation materials in buildings cannot be overstated. Effective thermal insulation is crucial for maintaining comfortable indoor temperatures, reducing energy consumption, and mitigating environmental impact. This article will explore the significance of thermal insulation materials in buildings and many benefit [4-8].

The Methods section discusses various types of thermal insulation materials commonly used in buildings, such as fiberglass, cellulose, expanded polystyrene (EPS), and mineral wool. It outlines their characteristics, performance attributes, and installation techniques. Additionally, it explores innovative materials like aerogel that offer superior insulation properties [9, 10].

Thermal insulation of buildings:

Temperature difference exists between the outset and inside of a building and at different units of a building. Heat is transferred from a warm to a cool place. The transfer of heat may take place by conduction, convection or radiation. Heat transfer mainly happens due to conduction through solid building materials. This heat transfer depends on the conductivity of the intervening materials, the temperature difference between two surfaces, the thickness of the material, the area of exposed material and the time through which the heat flow takes place [11-15].

Convection and radiation also play their role in the process of heat transfer through the building materials. Convection may take place through large areas and the thickness of the building material by currents of air transmit. Similarly, polished

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surfaces on the exposed side of a building may retard the inward flow of heat and prevent heat penetration.

Energy Efficiency:

Thermal insulation materials play a vital role in enhancing the energy efficiency of buildings. By reducing heat transfer between the interior and exterior environments, insulation minimizes the need for excessive heating or cooling systems. This results in significant energy savings and reduced utility bills for building owners and occupants alike.

Building Insulation Materials:

Bulk insulation and reflective insulation are the most common insulation materials. Bulk insulation acts as a barrier to heat flow between the building and the outside. It can be purchased in rolls or boards, and it is typically made from glass wool, polyester, natural wool, or recycled paper. Reflective insulation is usually made from shiny aluminum foil that is laminated onto paper or plastic. It is used to keep buildings cool during warm months by deflecting radiant heat [16-19].

Insulating concrete forms are typically manufactured with polystyrene foam, polyurethane foam, cement-bonded wood fiber, or cellular concrete. Engineers place reinforcing steel bars inside the form before the concrete is poured to give it flexible strength. The forms are often permanently left in place after the concrete has cured to provide soundproofing, thermal insulation, backing for drywall, and space for electrical conduit and plumbing [20].

Spray foam is a type of insulation in which polyurethane and isocyanate foams are sprayed with a gun. This type of insulation can be sprayed onto concrete slabs, into wall cavities, and through drilled holes in drywall.

Figure 1. *Procces of situation.*

Comfortable Indoor Environment:

Insulation helps create a comfortable indoor environment by preventing heat loss during colder months and minimizing heat gain in hotter seasons. This regulation of temperature ensures a consistent and pleasant atmosphere inside buildings, regardless of external weather conditions. Insulated walls, roofs, floors, and windows maintain optimal temperatures while reducing drafts and cold spots.

Thermal insulation for buildings

Common available insulation materials

INSULATION MATERIAL	THERMAL CONDUCTIVITY W/MK - LESS INDICATES BETTER PERFORMANCE	THERMAL RESISTANCE M2K/W - MORE INDICATE BETTER PERFORMANCE	U - VALUE W/M2K
Mineral Wool			
Glass fibre	0.032 - 0.044	3.10 - 2.25	0.32 - 0.44
Rock fibre	0.035 - 0.044	2.85 - 2.25	0.35 - 0.44
Sheep's wool	0.042	2.38	0.42
Expanded polystyrene (EPS)	0.036	2.77	0.36
Multi-foils	0.040	The nature of this insulant does not lend itself directly to direct comparison on thermal resistance or stand alone U-value	
Hemp	0.039	2.56	0.39
Extruded polystyrene (XPS)	0.029 - 0.036	3.44 - 2.77	0.29 - 0.36
Polyurethane foam board (PUR)	0.22 - 0.29	0.45 - 3.44	2.22 - 0.29
Polyisocyanurate foam board (PIR)	0.021 - 0.022	4.76 - 4.54	0.21 - 0.22
Phenolic foam board	0.021	4.76	0.21
Evacuated panels - 20mm thk	0.004	5.00	0.20
Aerogel board - 10mm thk	0.013	0.77	1.29

Thermal resistance figures are based 100mm thickness of insulation material

Thermal conductivity figures are typical for each material and may vary slightly between manufacturers

U - values shown indicate heat loss in watts / sq.m degree for insulation product alone

Figure 1. *Procces of situation.*

How insulation works ? Insulation products are designed to frustrate the transfer of heat across the material itself. There are three methods of heat transfer: radiation, conduction and convection.

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Radiation

Any object whose temperature is higher than the surfaces that surround it will lose energy as a net radiant exchange. Radiant heat can only travel in straight lines. Introduce a solid object between points A and B, and they will no longer directly exchange radiant heat. Radiation is the only heat transfer mechanism that.

Conclusion

Convection is the transfer of energy via fluids (gases and liquids). It is this method that plays the greatest role in the liberation and transfer of heat in buildings. The most common propagation of this effect is from solid to gas, object to air, and then back again, typically as the air meets with the external building fabric.

The process is actually initiated by an energy transfer due to conduction, and is complicated by the level of water vapour that is supported by the air. The water molecules store heat given to them through conduction from warm surfaces. The water vapour and the air cannot be separated as gases. They will only part company when the saturated vapour pressure is reached, i.e. the quantity of water (albeit in vapour form) exceeds the level of heat available to maintain it as a gas (vapour), and therefore it condenses.

Condensation causes this latent heat to be released; the temperature to water vapour ratio alters, and once it has altered far enough the process will start again. The world's weather systems follow a very similar.

If air could be kept still and dry it would perform as a highly efficient insulant. However, if air is heated, its molecular structure expands and becomes less dense relative to the air surrounding it and so rises. As it progresses further from the heat source, it begins to cool. The molecules contract and increase indensity and sink back down. Air molecules are in a constant state of flux, dependent on the ambient temperature, and interference from any point, or background heat sources.

This process of heat transfer 'convection' is complicated by the fact that air will cool at a rate dependent upon the amount of water vapour saturation. The greater the saturation, the slower the cooling.

Cost Savings

Investing in quality thermal insulation materials can lead to substantial long-term cost savings for building owners. With reduced reliance on heating or air conditioning systems to maintain desirable temperatures, energy consumption can be significantly reduced – resulting in lower utility bills over time.

The Results section focuses on the advantages provided by thermal insulation materials. Firstly, it addresses their ability to minimize heat transfer through conduction, convection, and radiation. Secondly, it discusses their impact on reducing energy consumption by maintaining stable indoor temperatures throughout the year. Moreover, it elaborates on how proper thermal insulation can enhance occupant comfort by preventing drafts and temperature fluctuations

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Environmental Benefits

The use of thermal insulation materials contributes to environmental sustainability by decreasing carbon dioxide emissions associated with excessive energy consumption. By conserving energy resources, these materials help combat climate change while promoting eco-friendly construction practices.

Noise Reduction

Beyond temperature regulation benefits, thermal insulation also acts as a sound barrier between different areas within a building or from external sources such as traffic or industrial noise pollution. Properly insulated walls can significantly reduce noise transfer, providing a quieter and more peaceful living or working environment.

The Discussion section emphasizes the broader implications of using efficient thermal insulation materials in buildings. It underlines their role in achieving sustainability goals by reducing reliance on fossil fuels for heating and cooling purposes. Furthermore, it highlights how improved energy efficiency positively impacts both economic savings for building owners and a reduced carbon footprint for society.

Condensation Control

Effective thermal insulation also aids in condensation control within buildings. Insulation reduces the likelihood of condensation forming on cold surfaces, such as windows and walls, thereby preventing potential moisture-related issues like mold growth and structural damage.

Durability and Longevity

Adding thermal insulation materials to buildings enhances their durability by protecting against external weather conditions. Insulation helps prevent thermal expansion and contraction, reducing the risk of cracks, moisture penetration, and subsequent deterioration of building materials. This leads to a longer lifespan for the structure.

Conclusion

The Conclusion summarizes the key findings presented in this abstract. It reiterates that incorporating adequate thermal insulation materials into building design is crucial for achieving optimal energy performance while ensuring occupant comfort and environmental sustainability. From energy efficiency and cost savings to environmental benefits and enhanced comfort levels, thermal insulation materials play a crucial role in modern building construction. Investing in quality insulation not only reduces energy consumption but also ensures long-term sustainability while providing occupants with a comfortable living or working environment. As we strive for more sustainable solutions in construction, the importance of thermal insulation materials cannot be overlooked.

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