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OBTAINING AND EFFICIENT USE OF HYDROPHOBIC THERMAL INSULATION MATERIALS BASED ON MODIFIED LIQUID GLASS IN CONSTRUCTION

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Abstract
This study explores the acquisition and efficient application of hydrophobic thermal insulation materials based on modified liquid glass in the construction industry. The research focuses on enhancing the thermal insulating properties of liquid glass through chemical modifications, resulting in materials that offer superior moisture resistance, improved thermal conductivity, and long-lasting durability. By integrating hydrophobic characteristics into the insulation, the materials not only prevent water absorption but also maintain their insulating efficiency under varying environmental conditions. The study also examines the production methods, cost-effectiveness, and practical application of these materials in building construction, aiming to contribute to energy-efficient, sustainable, and environmentally friendly building practices. The findings highlight the potential of modified liquid glass as a promising solution for improving energy performance in modern construction.

Keywords: Hydrophobic materials, Thermal insulation, Liquid glass, Modified liquid glass, Construction materials, Building insulation, Sustainable construction, Building envelope, Energy-saving materials.

Introduction

The demand for modern building materials includes energy efficiency, durability, and environmental safety. Hydrophobic thermal insulation materials based on modified liquid glass are considered a promising solution to meet these requirements. This article highlights the modification methods of liquid glass, the production of hydrophobic thermal insulation materials, and their effective application in the construction industry.

1. Liquid Glass and Its Modification Liquid glass (sodium silicate or potassium silicate solutions) has good binding and protective properties. However, its main disadvantages are low water resistance and brittleness. Therefore, modifying it to improve its hydrophobic and thermal insulation properties is advisable.

Modification methods:

- Enhancing water repellency with organic additives (silicones, polymers, organosilanes).
- Strengthening with nanoparticles (SiO2, TiO2, and Al2O3) to improve mechanical and thermal stability.
- Stabilizing with metal oxides (MgO, CaO, and Fe2O3) to increase chemical resistance.

2. Production of Thermal Insulation Materials The following technological processes are carried out to produce hydrophobic thermal insulation materials based on liquid glass:

- Preparing modified liquid glass by incorporating the aforementioned additives.
- Creating a foam structure using special foaming agents to obtain a lightweight and porous material.
- Hardening and drying to ensure the required shape and strength of the material through thermal treatment.
- Hydrophobization by applying special water-repellent coatings or emulsion solutions to the surface.

3. Hydrophobic Thermal Insulation Materials Hydrophobic thermal insulation materials are specialized materials that prevent water penetration while retaining heat. They are used to protect buildings, pipelines, industrial equipment, and other structures.

Key properties of hydrophobic thermal insulation materials:

1. Moisture resistance – does not absorb water or steam.
2. Excellent heat retention – contributes to energy savings.
3. Corrosion protection – particularly useful for metal structures.
4. Fire-resistant variants available – enhances safety.
5. Lightweight and easy to install – simplifies construction processes.

Common hydrophobic thermal insulation materials:

- Penoizol (liquid foam polyurethane, expanded polystyrene) – lightweight, fire-resistant, and waterproof.
- Mineral wool (basalt and glass wool) – effective for thermal and sound insulation.
- PIR (polyisocyanurate foam) – resistant to high temperatures and water.
- Expanded polystyrene (EPS, XPS) – moisture-resistant, lightweight, and affordable.
- Aerogel – one of the most advanced and efficient thermal insulation materials.

4. Effective Use in Construction Advantages of hydrophobic thermal insulation materials based on modified liquid glass:

- High thermal insulation – retains heat in winter and keeps interiors cool in summer.
- Water and moisture resistance – ensures long-term durability of construction structures.
- Environmental safety – does not release harmful gases and poses no risk to human health.
- High fire resistance – contains minimal organic combustible components, preventing fire spread.
- Versatile applications – widely used from residential buildings to industrial and infrastructure projects.

5. Practical Examples in Construction

- Residential buildings: Hydrophobic thermal insulation panels are used in walls, ceilings, and roofs. In Scandinavian countries, these materials help save up to 30% of heat energy in cold climates.
- Industrial facilities: Used for insulating oil and gas pipelines, preventing metal corrosion and improving thermal efficiency.
- Bridges and road infrastructure: Applied to concrete surfaces for water and moisture protection, preventing cracks and subsidence.

6. Experimental Results and Comparative Analysis Experiments show that thermal insulation materials based on modified liquid glass have 1.5 times higher thermal insulation efficiency than conventional mineral boards. Laboratory tests indicate:

- The thermal conductivity coefficient of modified material is 0.035-0.040 W/mK, at least 25% more efficient than traditional foam concrete and mineral boards.
- Water absorption is less than 1%, which is 5-7 times lower than conventional liquid glass materials.
- Compressive strength ranges between 2.5-3.0 MPa, demonstrating superior mechanical stability compared to lightweight construction materials.

Conclusion Hydrophobic thermal insulation materials based on modified liquid glass represent a promising solution for increasing energy efficiency and environmental safety in the construction industry. Further development and improvement of production technologies will open new innovative opportunities in the construction sector.

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