

PREPARATION OF BASALT–CELLULOSE THERMAL INSULATION MATERIALS

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The advancement of many modern technologies requires the creation of efficient thermal insulation materials. The highest performance has been achieved with multilayer vacuum insulating screens, consisting of thermally separated layers using glass-paper-fiberglass materials as spacers. These materials typically contain 9–18% organic binders to provide mechanical strength. However, such binders reduce insulation efficiency by increasing thermal conductivity and releasing gases that prevent the formation of a high vacuum.

For the production of paper-like insulation materials, basalt fibers with a diameter of about 0.6 μm and a bulk density up to 15 kg/m^3 were used. Enhancing the strength of paper and cardboard is also important, as it allows their use not only for insulation but also in packaging and construction. To ensure economic feasibility, inexpensive and readily available raw materials—such as agricultural waste—are of great interest. Previous studies have shown that fibers from cotton and Jerusalem artichoke waste can be used to make paper-like materials, although their low strength can be improved by adding basalt fibers to the pulp.

Heat-insulating cardboard made from superfine basalt fibers and polyvinyl acetate (PVA) emulsion was produced using a specialized technological process that includes three main stages: binder preparation (PVA), sheet formation on a conveyor belt, and drying in a conveyor dryer using hot air or exhaust gases. Based on this technology, several grades of basalt cardboard (TK-4, TZK-5, ATM-12) were manufactured in sizes ranging from 300–1200 mm in length, 300–1000 mm in width, and 4–12 mm in thickness. The physical properties of these basalt cardboards are presented in Table 1.

Table 1

Comparative characteristics of cartons

Parameter	Basalt board	Asbestos board
Application temperature, °C	-260+700	more 600
Density kg / m^3	70-110	1000-1300
Coefficient of thermal conductivity at 20 + 5 $\text{kcal} / \text{m} * \text{h} \text{ hail}$	0,03	0,012
Humidity not more than	2	3

Combustibility	Difficultly combustible	
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Basalt heat-insulating cardboard was developed using a clay binder. Based on basalt super-thin fibers (BSTF) and clay bentonite, sheet-type insulating materials (grades TK-1 and TZK-6) with thicknesses ranging from 2 to 12 mm were produced [2], [3].

The material composition includes 88–98% basalt super-thin fibers (diameter up to 1.5 μm) and 2–12% clay binder. The production process consists of three main stages: preparing a clay-fiber slurry, forming a continuous mat using a vacuum filter, and drying the formed sheet in a conveyor dryer. After drying, the material is cut to the required sizes and packaged.

These basalt-based insulating sheets are used as cushioning thermal insulation in shipbuilding, aviation, chemical, and other industries. They exhibit excellent temperature resistance, operating effectively between -260°C and $+750^{\circ}\text{C}$.

Basalt fibers produced in Uzbekistan from Osmansay deposit basalts demonstrate a combination of properties that rank them among the leading mineral fibers globally. The appearance and key characteristics of these basalt fibers, as well as those from Jerusalem artichoke (topinambour) raw materials, are presented in Table 2.

Properties of basalt BSTV	Values	Properties of topinambour	Values
Base length, mm	6-12	Whiteness,%	78,0
Modulus of elasticity, GPa	84,2+1,7	Content of a + cellulose,%	88,6
Strength, MPa	2245,3	Ash content	0,79
Average fiber diameters, mkm	Less 0,8	Humidity,%	3,0-3,5
Thermal conductivity at an average temperature of 50-300 $^{\circ}\text{C}$, Wt / m. K	0,02-0,06		

A paper-like composite material was produced using Jerusalem artichoke and "Superthin" brand basalt fiber. The dried Jerusalem artichoke was first moistened until its volume expanded 2–3 times. It was then ground into a homogeneous, gel-like mass, resulting in roughly a twofold increase in bulk density. A 5–20% carboxymethyl cellulose (CMC) solution was added, along with 5% by volume of basalt fiber fragments measuring 1–3 mm.

The resulting mixture formed a layered composite structure. The pulp was cast onto a fine mesh screen (maximum opening 40 μm) or a smooth surface to form sheets. Drying occurred in two stages: initial drying reduced the residual moisture to below 6.5%, followed by final drying at $58\text{--}68^{\circ}\text{C}$ for 12 hours.

The produced paper composite, based on Jerusalem artichoke and basalt fiber from the Osmansay deposit, exhibited the properties listed in Table 2.

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