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THERMAL INSULATION PLATES WITH FIBER STRUCTURE BASED ON PLANT RAW MATERIALS

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Innovative materials based on fibrous plant raw materials are presented. The above thermal insulation boards were developed at Polotsk State University named after Euphrosyne of Polotsk. For thermal insulation, the main thermal characteristics are indicated.

Environmental safety and economic efficiency of thermal insulation of buildings at the current scale of heat consumption largely depends on thermal insulation materials. Thermal insulation serves to reduce heat losses and ensure acceptable temperature of the insulated surface. This article presents thermal insulation boards on structure-forming materials made of plant fibers for various countries of the world, developed in the green building laboratory of the Department of Construction Production of Polotsk University.

Thermal insulation boards based on jute fibers. Insulation made from jute fibers contains a fibrous structure-forming material, liquid soda glass as a binder and the addition of lime and gypsum. Thermal insulation has a thermal conductivity coefficient of 0,046–0,063 W/(m·°C) and a tensile strength at 10% deformation of 0.11–0.59 MPa with an average density of 86 to 239 kg/m^3. The best thermal conductivity of 0.046 and 0.047 W/(m·°C) is achieved by insulation materials characterized by an average density of 142 and 170 kg/m^3. The maximum strength indicators at 10% deformation of 0,55 and 0,59 MPa were obtained for compositions with an average density of 170 and 198 kg/m^3 [1].

Thermal insulation boards made of sphagnum moss. Research on the production of thermal insulation based on sphagnum moss was carried out at Polotsk State University named after Euphrosyne of Polotsk [2]. Liquid glass was used as a binder. Thermal insulation materials are characterized by the following thermal indicators: average density 150–170 kg/m^3 and thermal conductivity coefficient from 0,034 to 0,04 W/(m·°C). When replacing 20–30% of sphagnum moss with crushed straw, the thermal conductivity of the insulation increases to 0,046 W/(m·°C) [3].

Thermal insulation boards made from fibrous waste from cotton production. For the countries of Central Asia, cotton production waste can be used as a structure-forming material [4]. Modified liquid glass is used as a binder. The insulation is shown in Figure 1. Thermal insulation at a density of 40 to 100 kg/m3 provides a thermal conductivity coefficient of 0.037–0.041 W/(m·°C). The lowest thermal conductivity coefficient of 0,037 W/(m·°C) corresponds to a density of 50−60 kg/m3. However, with the introduction of lime and gypsum, the insolubility of the binder and the thermal conductivity of the insulation increases to 0,039 W/(m·°C). At a relative air humidity of 60–70%, the sorption humidity of thermal insulation materials based on cotton fibers is 11–12%. The thermal conductivity coefficient of the slabs at the specified sorption humidity is 0,043–0.045 W/(m·°C).

Figure 1. – Thermal insulation board made from fibrous waste from cotton production

Thermal insulation boards based on flax tow. The secondary raw material of flax fibers used as a structure-forming material for thermal insulation is flax tow [5, 6]. Sodium liquid glass is used as a binder. Gypsum and lime are also used to increase the insolubility of the binder.

Based on the results of comprehensive tests, it was established that thermal insulation boards based on flax tow have an average density of 40 to 120 kg/m^3 and provide a thermal conductivity coefficient of 0,035−0,042 W/m·°C. The sorption humidity of the insulation materials under consideration at a relative air humidity of 60% to 80% is 14−16%. The vapor permeability coefficient of thermal insulation materials based on tow at a density of 40-120 kg/m^3 is 0,34–0,41 mg/(m·h·Pa).

Full-scale tests confirmed the possibility of using thermal insulation as an effective insulation for buildings and structures. Samples of thermal insulation boards were laid between the wooden beams of the attic space and between the wooden posts of a wooden frame house, and were also mounted to a brick wall when installing a ventilated insulation system. In the process of ongoing monitoring for four or three years, no damage, deformation, or changes in the geometric

Thermal insulation boards based on flax from eucalyptus fibers. A preliminary study of eucalyptus bark made it possible to establish that, based on fibers, it is possible to obtain a structure-forming material for the production of insulation materials using natural raw materials. The use of eucalyptus bark with a moisture content of 20−30% during grinding reduces the amount of dust produced by 4−5 times and helps to increase the average fraction to 20−30% in the total mass of fibers. The best indicator of thermal conductivity is provided by the middle fraction of eucalyptus bark fibers. With a density of 70−90 kg/m^3, the thermal conductivity coefficient of eucalyptus bark fibers is 0,049 W/(m·°C) [7]. In further studies, it is possible to introduce a second plant component in order to further reduce the thermal conductivity coefficient of the structural composition.

Interest in the creation of safe thermal insulation materials from raw materials of plant origin is associated with increased requirements for the ecology of the home. Fibrous plant raw materials are promising raw materials for the production of thermal insulation materials. Due to their properties, the structure-forming materials presented in the article provide high thermal performance, environmental friendliness and help maintain favorable temperature and humidity conditions in the premises.

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