

Porous materials based on flax boon technology

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Abstract. In the article we considered the technological modes of obtaining heat-insulating materials on the basis of flax boon. The technology of gas-concrete blocks on the basis of flax boon production is given. The data on the structure and properties of organic aggregate (flax boon) are presented.

1. Introduction

The use of secondary resources in the production of building materials is a significant reserve for improving the efficiency of construction. Among such resources it is possible to allocate agricultural waste: flax boon, hemp, jute, kenaf, stalks of cotton, rice straw, etc.

Studies on the use of waste products of flax processing as raw materials for the production of building materials have been conducted since the beginning of the 20th century. Obtaining construction materials based on flax boon is mainly carried out using the following technologies: the manufacture of products based on flax boon without an astringent, the drawback of this method is the high energy intensity; the production of plates from the flax boon with the use of phenol-formaldehyde and urea-formaldehyde resins as binders, the disadvantage is the release of harmful substances into the environment. At present, building materials based on plant raw materials (peat placers, reeds, etc.) cannot be attributed to perspective insulating materials because of their flammability, insufficient water and bio resistant. As a rule, they are used only in temporary buildings and structures [1-6].

The analysis of technical and patent literature did not reveal the compositions and parameters for the production of cellular concrete on vegetable aggregate - flax boon.

The relevance of the work is due to the fact that heat-insulating materials based on vegetable raw materials are characterized by high thermo-technical indicators, besides, from the ecological point of view, the problem of recycling agricultural waste is solved and at the same time it becomes possible to obtain environmentally friendly building materials. In addition, the use of waste products of flax processing in the manufacture of thermal insulation materials will reduce their cost through the use of incidentally received, not currently in use, raw materials [7-8].

Based on the analysis of the problem of obtaining heat insulation products on the basis of flax boon, the goal and tasks of the work are formulated. The purpose of the work is the development of technology for obtaining heat-insulating mesh materials based on flax boon. To achieve the goal it is necessary to solve the following tasks:

1. Determine the composition and properties of organic aggregate – flax boon.



2. Select the optimal ratios of flax boon and binders in the preparation of pressed, porous and granular materials.

3. Optimize the composition and technological parameters of obtaining heat-insulating materials of various structures on the basis of flax boon.

2. Methods and materials

In our research, the composition and properties of the organic aggregate were determined. Flax boon is a by-product from flax processing and one of the most common agricultural wastes. Flax is an annual plant whose fiber length, depending on the species and growth conditions, can be 4 mm or more with a width of 0.01 ... 0.03 mm. For flax fibers, the following structural features are characteristic: sharpened ends, narrow threadlike channel (cell cavity), reaching the ends of the cell, strongly and uniformly thickened shells, slit-like simple pores. The stems of flax during the separation of fiber in the processes of braking and scutching are destroyed, and the falling lignified parts form a flax boon. Dimensions of these particles range from 1 to 10 mm in length, and from 0.3 ... 1 mm in thickness. The main portion of flax production and processing of flax (about 70%) falls on the Central and West Siberian regions. In Siberia flax plants are located in the Omsk, Novosibirsk regions, Altai Territory [9].

The material composition of the initial component - flax boon, was studied by infrared spectroscopy using the "Scimitar FTS 2000" infrared spectrometer (Figure 1). An increased content of lignin in the flax boon was found up to 44-46%, confirmed by absorption bands on the IR spectrum at 1653 cm⁻¹, as well as bands in the range of 1540-1510 cm⁻¹, common to vibrations of rings. An intense structured band (max 1048 cm⁻¹) is observed in the range of 1250-1050 cm⁻¹. Deformation vibrations of (OH) and (C-O) groups, as well as stretching vibrations of (C-OH) groups, whose absorption bands overlap, become apparent here. The hydroxyl groups cause background absorption in the range of 700-500 cm⁻¹ [10].

Cellulose and lignin, which make up the bulk of the cell walls of flax boon and determine their mechanical strength, are sufficiently persistent substances and do not exert any adverse effect on the hardening process of the binder [11-15]. The hemicellulosic part of the flax boon is a complex organic substance (polysaccharides) capable of hydrolyzing and passing into water-soluble sugars in an alkaline medium (which is a cement slurry covering an organic aggregate). Water-soluble sugars are a "cement poison", i.e. substances that prevent the hardening of clinker minerals. However, the content of hemicellulose in flax boon is not large (up to 11%).

Flax boon has bulk density - 110 ... 120 kg / m³, humidity - 15 ... 20%, hygroscopicity - 24..26%. The ignition temperature is 210 ... 220 ° C, the thermal conductivity in the dry state is 0.037 ... 0.041 W / (m ° C). Flax boon in dumps has a moisture content of 12-30%. At room temperature for 3-5 days there is a stabilization of moisture, as its drying decreases its bulk density [4].

When determining the composition and properties of the aggregate, it is noted that the parameters for obtaining building materials based on flax boon differ from materials based on wood waste due to the difference in their properties. Such specific properties of organic fillers, such as moisture deformations, pronounced anisotropy, elasticity, are not significantly manifested in flax boon, in comparison with wood [16-18].

The production of materials based on flax boon can be organized at the factory for the manufacture of products from cellular concrete or on a newly designed production line. The most economically and technically justified is the design and construction of the plant on or near the enterprise - a supplier of flax waste.

Raw materials and compounds. Mineral binders, fillers, blowing agents and corrective additives are used for the manufacture of cellular concrete products. Portland cement was used as an astringent to obtain non-autoclaved cellular concrete [19].

Waste processing - thin-boned flax boon (fraction 0.63-2.5 mm) is used as a filler. The physical composition of the flax boon consists of lignin - 46, cellulose - 38, hemicellulose -10.5, fats, wax - 4.8, water-soluble substances - 0.7. As the gas-forming admixture aluminum powder PAP-1, PAP-2, which

meets the requirements of GOST 5494-95 "Aluminum pigment powder", is used. Prepare an aluminum suspension, we need sulfanole (alkyl benzene sulfate) that meets the requirements of TU 6-01-1001-77. As a mineralizer of vegetative filler, liquid sodium glass that meets the requirements of GOST 13078-81 is used. To create an active alkaline medium, necessary to ensure the reaction of gas evolution in the production of non-autoclaved aerated concrete, the mixture is injected with ground quick lime or powder lime. To ensure the stabilization of the structure of freshly formed products, to reduce the draft of the porous mass and to increase the strength, finely dispersed mineral additives can be introduced into the raw mix, which include the use of microsilica suspension, ashes of thermal power stations, gypsum and rim gypsum stone, etc. Water for the preparation of a cellular-concrete mixture must satisfy the requirements of GOST 23732-79, the hydrogen index of which is 4-9 units.

Mixtures compositions to make construction products from cellular concrete with an average density of 300-400 kg / m³ are given in Table 1.

Table 1. Mixtures compositions for heat insulating cellular concrete products of non-autoclaved hardening production.

Composition	Mixture components	Content of components. % by weight
1	Portland cement	56,641
	Flax Boon	28,326
	Air building lime	5,664
	Liquid sodium glass	7,079
	Aluminum powder	0,661
	Surfactant (sulfonol)	1,637
	Galleting	1-1,05
2	Portland cement	54,867
	Flax Boon	26,726
	Air building lime	5,487
	Liquid sodium glass	6,372
	Aluminum powder	0,663
	Surfactant (sulfonol)	1,637
	Stabilizing agent of structural strength	4,248
	Galleting	0,85 - 0,9

3. Production technology of aerated concrete products

Flax boon (filler) is grinded to a fraction of 0.63-2.5 mm in a cutting mill and fed to the storage bunker. Cement is stored in spare silos. The lime is subjected to fine grinding in a flint mill and stored in a stock silo of lime.

Flax boon and liquid glass are dosed into a mixer for the preparation of a mortar. Simultaneously with these materials, water is supplied to the mixer by jets to a moisture content that provides mineralization of the flax boon.

Aerated concrete mixture is prepared as follows. On the basis of mineralized vegetable filler, a sludge with a moisture content of 65% is prepared. The batch of sludge and the mixture components are loaded into a self-propelled gas concrete mixer machine with the agitator in operation. The mixer is loaded in the following order: slurry, astringent, lime and stabilizer additive are supplied at the beginning, the mixture is mixed for 4-5 minutes, after which an aqueous suspension of aluminum powder is dosed. All components of the molding slurry are mixed for 1-2 minutes, and the aerated concrete is poured into metal molds. To intensify the interaction of aluminum powder with calcium hydroxide water is preheated to 50-60°C [20-22].

Before the thermal treatment, the molded products are held for 3-4 hours. During this period, gas evolution, a set of structural strength of products and a cut of the formed "crust" with the plastic strength of the porous aerated concrete mass equal to 0.04-0.05 MPa take place.

Thermal treatment of non-autoclaved hardening products is carried out in drying chambers for 4-5 hours at a temperature of 50-60⁰ C.

After thermal treatment, the products in the molds are fed into the molding, and the finished blocks are transported to the finished product stores.

Types of heat-insulating cellular concrete products and their requirements. Small blocks are used to build internal walls and partitions, as well as insulation of building structures. It is forbidden to use cellular concrete blocks for the walls of cellars, socles and other places where strong moistening of concrete is possible. The characteristics of the blocks are given in Table 2.

The weight of one block is from 4 to 7 kg. The blocks have form of rectangular parallelepipeds.

The permissible deviations for linear dimensions of small blocks are: length and width 2-4 mm, thickness 1-3 mm, depending on the category of product quality.

Table 2. Technical characteristics of aerocrete blocks.

Conditional brand of the block	Block mark according to GOST	Dimensions, mm			Class of porous concrete	Density, kg/m ³	Product volume, m ³
		l	b	h			
B2	B-40.20.20	400	200	200	B0,5	300	0,048
B3	B-40.20.20	400	200	200	B0,75	350	0,024
B4	B-40.20.20	400	200	200	B1	400	0,036

Frost resistance of blocks B4 - F10, for blocks B1 and B2 frost resistance is not standardized. The release humidity for the B4 blocks is 25%, for the brands B1 and B2, the release moisture is not more than 10%. The thermal conductivity of blocks with an average density of 300-400 kg / m³ is 0.076-0.091 W / (m0C), the compressive strength is 0.6-1.1 MPa.

4. Control of production and quality of finished products

Production control is carried out according to the following scheme: quality control of raw materials components - control of the accuracy of dosing - quality control of the molding mass - control of the molding process - control of the thermal treatment process - quality control of the finished product.

5. Conclusion

The porous materials based on flax boon technology has been developed. The composition of the raw mix for the production of non-autoclaved aerated concrete, including the following components (% mass): Portland cement - 27-35; flax boon - 22-25; quartz sand - 13-15; ground lime - 2,7-3,3; aluminum powder - 0,043-0,05; water - the rest, is determined.

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