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INVESTIGATION OF THE CONTENT OF SLUDGES OF CHEMICAL WATER TREATMENT OF COMBINED HEAT AND POWER PLANTS ON THE PROPERTIES OF CLINKER CERAMIC BUILDING MATERIALS

ИССЛЕДОВАНИЕ ВЛИЯНИЯ СОДЕРЖАНИЯ ОСАДКОВ ХИМИЧЕСКОЙ ВОДОПОДГОТОВКИ ТЕПЛОЭЛЕКТРОЦЕНТРАЛЕЙ НА СВОЙСТВА КЛИНКЕРНЫХ КЕРАМИЧЕСКИХ СТРОИТЕЛЬНЫХ МАТЕРИАЛОВ

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Abstract. The article presents the results of research of the anthropogenic products content in clinker ceramic materials as a result of chemical water treatment at the heat and power plant. The research resulted in the possibility of using of technogenic products of chemical water treatment of CHPP in the production of clinker ceramic materials. Also, the area of rational values of the content of inorganic waste in the ceramic mass and the value of the sintering temperature is determined.

Аннотация. В статье приведены результаты исследования содержания техногенных продуктов химической водоподготовки ТЭЦ в клинкерных керамических материалах. В результате проведённых исследований установлена возможность использования техногенных продуктов химводоподготовки ТЭЦ в производстве клинкерных керамических материалов и определена область рациональных значений содержания неорганических отходов в составе керамической массы и значение температуры спекания.

The term "building ceramics" refers to materials and products made of mixture of clay or loam and various additives, manufactured by ceramic technology – preparation of raw materials, molding, drying and firing to a stone-like state. According to its purpose the building ceramics is divided into the following types: wall and roofing products, products for facade cladding, architectural and artistic design of the interior space of buildings, aggregates for lightweight concrete, thermal insulation and sanitary

ware, floor tiles, road bricks, refractory and acid-proof products, products for underground utilities – sewage pipes and drains [1].

Clinker or clinker ceramics is an artificial stone material of a set form, made of clay by firing it at temperatures up to 1300 °C to complete sintering without vitrification of the surface. They are referred to the so-called coarse-grained stoneware. In contrast to conventional products of rough building ceramics the clinker ceramic materials have higher mechanical strength (in compression, friction and bending), lower water absorption (0–6 % by mass). They are used for finishing of facades, covering of bridges, manufacturing of steps, etc. [1].

The main raw materials used for the production of clinker ceramic materials are clays, and kaolins. To give the necessary properties in the manufacture of clinker ceramic materials pigments of BaC_2 are used to bind water-soluble salts, pore-forming, burning, softening or plasticizing additives. Powder-forming materials (substances that dissociate during firing with release of gas, for example, CO_2 (ground chalk, dolomite), or burn out, are added to the raw mass to get light ceramic products with higher porosity and lower thermal conductivity. Burning additives: sawdust, crushed lignite or hard coal, coal combustion plant wastes, TPP ash and lignin not only increase the porosity of ceramic wall products, but also some of them contribute to a uniform sintering of ceramic tiles. Plasticizing additives are highly plastic clays as well as surface-active substances [1].

In the production of clinker ceramic building materials, firing is the most energy-consuming step in the production of ceramic products. Recently, technologies allowing to reduce energy costs at the firing stage through the use of various additives, such as burners, plasticizers, etc., are increasingly in demand [2].

At the same time the solution of the actual national economic problem on rational use of natural resources assumes development of effective wasteless technologies at the expense of complex use of raw materials that leads to minimization of ecological damage [3].

Within the framework of the project "Innovative, resource-saving technology for manufacturing paving tiles using industrial waste", carried out by the State Research Institute "Physical Material Science, New Materials and Technologies", the Department of Ecology and Chemical Technologies together with Obolsky Ceramic Plant Company conducted research on the possibility of using man-made products of energy complex (sludge of chemical water treatment of thermal power plants) as an additive in the manufacture of ceramic clinker materials [3].

Preliminary analysis of the literature showed the lack of information on the use of man-made products of chemical water treatment of thermal power plants as an additive in the manufacture of clinker ceramic materials. To conduct further research in accordance with the requirements of STB 1450-2010 at Obolsky Ceramic Plant the recipe was developed for a composition of raw materials and manufactured samples of ceramic clinker paving tiles (clinker brick) using sludge chemical water treatment CHPP [3]. The aim of the study formulated the following task: to determine the rational values of the content of sludge of chemical water treatment of thermal power plant,

providing the required physical and mechanical properties of tiles and temperature regime of the final firing with the lowest energy consumption [2].

The experiment was conducted according to the D-optimal matrix Kono 3^2, implementing all possible combinations of varying the input parameters. As a result of the experiment in accordance with the matrix different variants of ceramic mixture compositions were developed. After further processing of the results, mathematical models of the dependence of output parameters on input factors were obtained. Having carried out the analysis of the received models, it is possible to draw the following conclusions [2]:

– the compressive strength is influenced by the temperature of the final firing of tiles and the content of precipitation of chemical water treatment of thermal power plant in the mixture. Increasing the temperature of the final firing of tiles from 1100 °C to 1300 °C leads to an increase in the compressive strength; however, at the same time, increasing the precipitation of chemical water treatment CHPP from 1 to 3 % leads to a gradual decrease in the compressive strength;

– on the bending strength is characterized by the influence of the temperature of the final firing of tiles. Increasing the final firing temperature of the tiles from 1100 °C to 1300 °C leads to an increase in the bending strength. At the content of sludge of chemical water treatment of CHPP 1 % the minimum value of the bending strength is observed;

– the density is significantly influenced by the temperature of the final firing of the tiles. The content of precipitation of chemical water treatment of CHPP in the composition of ceramic mass is a minor factor of this indicator. Increasing the temperature of the final firing of tiles leads to a denser clinker structure;

– water absorption is equally influenced by both factors. With the increase of firing temperature with low content of precipitation of chemical water treatment the lowest water absorption is observed – 2.5 %. Maximum water absorption (4.5 %) corresponds to the minimum temperature of the final firing of tiles and the highest content of precipitation of chemical water treatment of CHPP.

As a result, the area of compromise solutions at the set restrictions is revealed: minimum density is 2000 kg/m^3; minimum ultimate strength in compression is 25 MPa; minimum ultimate bending strength is 1,7 MPa; maximum water absorption is 4 %. Analyzing the area of rational solutions, we can recommend the following values of the parameters of the manufacturing process of tiles [2]:

1) The temperature of the final firing of tiles to be set in the range from 1150 ºC to 1300 ºC;

2) The content of the sludge of the chemical water treatment of the thermal power plant shall not exceed 2.6 %.

A pilot batch of tiles was manufactured using parameters from the area of optimum: the temperature of the final firing of tiles – 1150 ºC and the content of sludge from chemical water treatment of CHPP in the ceramic mass – 2 %. During the laboratory tests conducted by the technical control department of Obolsky Ceramic Plant it was found that the experimental samples of tiles according to STB 1787-2007 "The ceramic clinker brick. Technical conditions" correspond to a class A [4].

The research of physical and mechanical properties of experimental samples of ceramic clinker tiles conducted at Obolsky Ceramic Plant showed the possibility of using of man-made products of power complex (sludge of chemical water treatment of combined heat and power plants) as an additive in the manufacture of ceramic building materials of general purpose. Addition of sludge of chemical water treatment allows to reduce the firing temperature of products, which is important in terms of energy saving.

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ENZYME-CONTAINING SILICONE COMPOSITIONS IN THE TECHNOLOGY OF SOFTENING COTTON FABRICS

ФЕРМЕНТСОДЕРЖАЩИЕ СИЛИКОНОВЫЕ КОМПОЗИЦИИ В ТЕХНОЛОГИИ УМЯГЧЕНИЯ ХЛОПЧАТОБУМАЖНЫХ ТКАНЕЙ

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