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QORAQALPOG'ISTONNING MAHALLIY TABIIY XOMASHYOLARIDAN FOYDALANIB SILIKAT G'ISHTINI OLISH

PRODUCTION OF SILICATE BRICK BASED ON NATURAL MINERAL RAW MATERIALS OF KARAKALPAKSTAN

PRODUCTION OF SAND_LIME BRICKS BASED ON NATURAL MINERAL RAW MATERIALS FROM KARAKALPAKSTAN

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Abstract

The silicate bricks produced by the Nukus and Muynak sand and 15-25% of Aktau and Jumurtau lime were mixed using 75-85% Nukus and Muynak sand, and 15-25% of Aktau and Jumurtau lime.

Abstract. This article presents an analysis of the processes and results of the study on all types of silicate brick solidification by autoclave and manipulation. In testing, model mixtures of sand from Nukus and Muynak and 15-25% lime from Aktau and Djumurtau were included.

Keywords: Lime, dune sand, autoclave, sand-lime brick, calcium carbonate, hardening, silicate mixture.

INTRODUCTION

This article analyzes the processes and results of studying all types of sand-lime brick hardening during autoclave processing. Testing involved model mixtures of Nukus and Muynak sand and 15-25% lime from the Aktau and Djumurtau deposits. Studies of the chemistry of the hardening process of sand-lime bricks at

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elevated temperatures and pressures can reveal the formation of new chemical compounds that differ from the hydration products characteristic of normal hardening conditions.

One method for studying the initial stages of the hardening process of a lime-siliceous mixture is to study the kinetics of structure formation by measuring changes in the plastic strength of freshly prepared paste. It was of interest to study the effect of dune sands on structure formation in hardened sand-lime brick pastes.

LITERATURE REVIEW

Sand-lime brick production is characterized by a relatively simple technological process, a high level of mechanization and partial automation, comprehensive equipment, and the ability to use various raw materials and industrial waste. The production cycle time is 5-10 times shorter, and specific capital investment, fuel and energy consumption, and unit production costs are 1.5-2 times lower than those of ceramic brick production. / 1 /.

Improvements in sand-lime brick production are based on the achievements of Uzbekistan, which is conducting research to understand the nature and patterns of physical and chemical processes, improve the technology, and enhance the quality of sand-lime bricks. This provides an opportunity to create a theoretical basis for further improvements in autoclaved material technology / 2 /.

Research to improve the technology of lime-siliceous materials in various areas has been conducted.

Considerable attention has been paid to intensifying the autoclave curing process of silicate materials.

Research on the effect of adding ground quartz sand, clay, ash, and slag on the curing rate and strength of products has been of great importance for the further development of autoclaved silicate material technology / 3 /.

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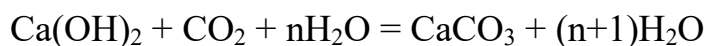
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Research has established that ground quartz sand is an effective additive, the introduction of which into the batch significantly reduces autoclave processing time and increases the density and strength of products. To conduct the research, model mixtures for sand-lime brick production using traditional technology were prepared using 75-85% Nukus and Muynak sand and 15-25% lime from the Aktau and Jumurtau deposits.

METHODOLOGY

Depending on the type of lime and the conditions under which it hardens, three types of hardening are distinguished: carbonate, hydrated, and hydrosilicate.

Carbonate hardening is the gradual hardening of mortar or concrete mixtures made with slaked lime when exposed to carbon dioxide. Hardening is caused by the simultaneous occurrence of two processes: the crystallization of calcium oxide hydrate from a saturated aqueous solution.



Hydrate hardening is the process of gradual transformation of lime mortar and concrete mixtures based on ground quicklime into a solid rock-like body. This occurs as a result of the interaction of this lime with water and the formation of calcium oxide hydrate.[4]

Hydrate hardening is the process of transformation of lime-siliceous mixtures into a solid rock-like body caused by the formation of calcium hydrosilicates, particularly during heat and moisture treatment in an autoclave with saturated steam under a pressure of 0.9-1.6 MPa, which corresponds to temperatures of 174.4-200°C. [5]

The high temperature of autoclave processing in the presence of liquid water in the material being processed dramatically accelerates the chemical interaction between calcium oxide hydrate and quartz sand or another siliceous component.

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Fine-grained lime-sand (silicate) concretes are typically produced from mixtures of lime (8-12%) and quartz sand (88-92%).

During autoclave processing, the interaction of lime and silica produces significant quantities of calcium hydrosilicates, ensuring high strength and durability of the resulting products.

K.O. Lone [6-7] developed a theory for the autoclave processing of lime-siliceous materials. According to this theory, autoclave processing consists of three stages of the steaming process.

- the first includes the period from the moment steam is released into the autoclave until the workpiece reaches the specified temperature;
- the second is characterized by a constant temperature and specified steam pressure in the autoclave. In this case, all the chemical processes that cause the formation of cementitious new formations and the hardening of lime-sand or concrete products are maximally developed;
- the third stage begins when steam access to the autoclave is stopped and includes the cooling time of the products in it until they are removed.

CONCLUSIONS AND SUGGESTIONS

For the study, model mixtures for sand-lime brick production using traditional technology were prepared: 75-85% Nukus and Muynak sand and 15-25% Aktau and Jumurtau lime.

Before preparing the calculated mixtures, the lime used was slaked separately to an activity of 90.1% and then added to the mixture. The mixtures were mixed in a laboratory mill.

Prism-shaped samples measuring 7.5 x 3.5 x 1.2 cm were molded from the prepared mixtures at a pressure of 0.8 MPa. The prepared samples were transferred to a laboratory autoclave and subjected to hydrothermal treatment.

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Based on numerous experiments, the following optimal treatment regime was selected: raising the steam pressure in the autoclave to 0.8 MPa for 2 hours, holding at the optimal pressure (0.8 MPa) for 6 hours, releasing the steam and reducing the pressure to 0.5 MPa over 1 hour, and releasing the steam and reducing the pressure to atmospheric pressure over 2 hours. The total duration of the entire cycle: $2 + 6 + 1 + 2 = 11$ hours.

X-ray phase analysis was used to study the phase formations of the experimental sand-lime brick composition 7, 28, and 180 days after autoclaving. According to X-ray phase analysis, clearly defined intense diffraction maxima of quartz ($d=0.334;0.245;0.197;0.181$ nm) and α -hydrate C_2S ($d=0.224;0.208;0.187$ nm) are observed in hydrated silicate brick. Hydrated silicate brick samples cured for 28 days show clear diffraction maxima of quartz ($d=0.334;0.181$ nm), tobermorite ($d=0.307; 0.280; 0.167; 0.161$ nm) and low-basic hydrosilicates of the C-S-H(B) type ($d=0.240; 0.210; 0.183$ nm) in the X-ray diffraction pattern. After curing for 180 days, the samples exhibit clear diffraction maxima of quartz ($d=0.334; 0.280; 0.197$ nm), tobermorite ($d=0.307; 0.280; 0.252; 0.247; 0.183; 0.171; 0.167$ nm), and $C_2SH(C)$ ($d=0.280; 0.269; 0.252; 0.247; 0.218; 0.208; 0.192; 0.187$ nm).

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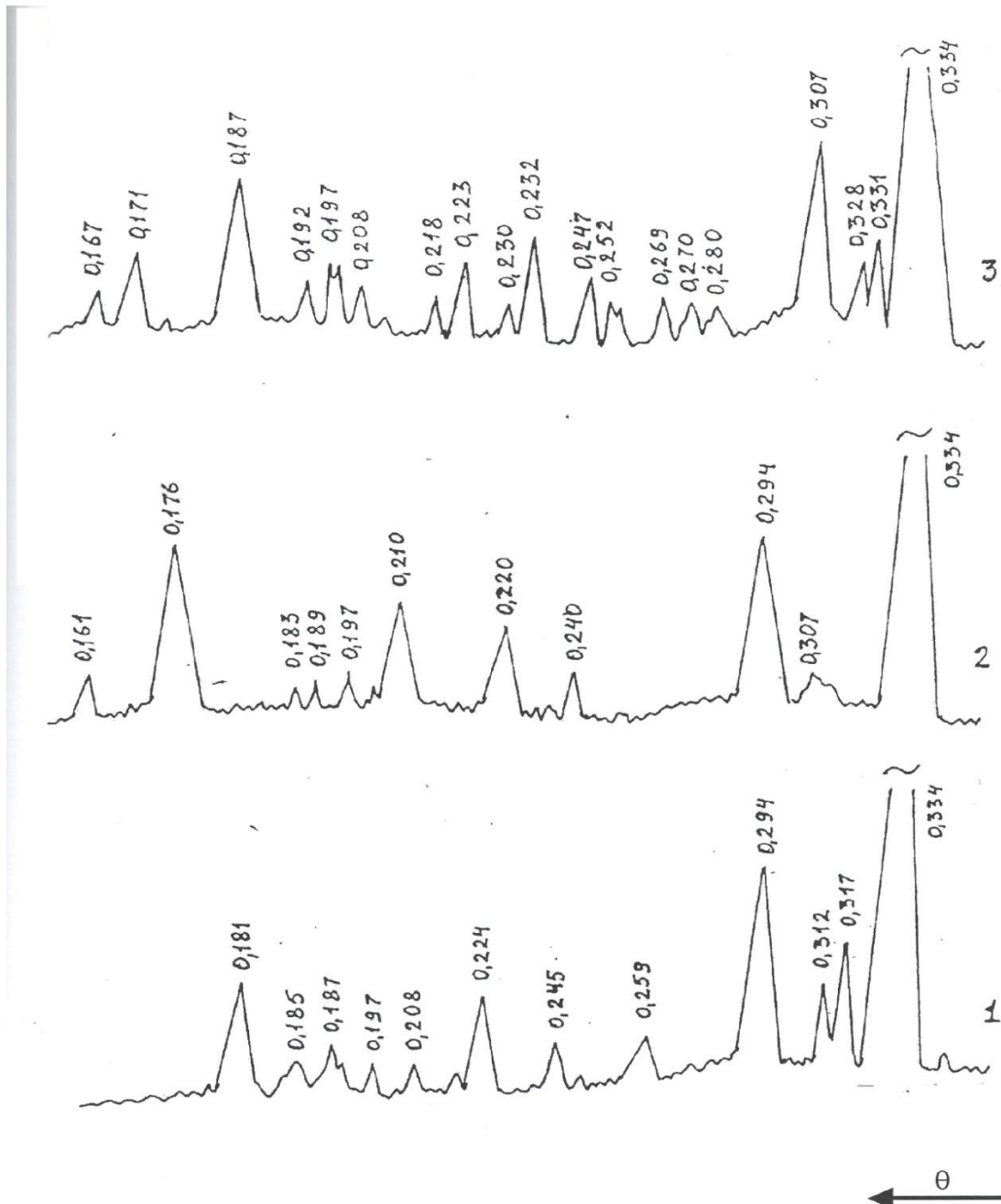


Fig. 1. X-ray diffraction patterns of a mixture of 75% Nukus dune sand + 25% Aktau lime, processed in an autoclave at a pressure of 0.8 MPa after 1) 7 days; 2) 28 days; 3) -180 days of curing

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The DTA curves of the 7-day-old samples after autoclaving show endothermic effects at temperatures of 260°C and 560-580°C, which correspond to the dehydration of C₂SH(C). The endo effect at 630°C corresponds to the polymorphic transition of γ-C₂S to β-C₂S.

The DTA curves of the 28-day-old samples show the dehydration of C-S-H(B) water in the temperature range from 580°C to 780°C. Tobermorite dehydrates at 270°C.

According to the DTA data for the 180-day-old samples of normal storage after autoclaving, dehydration of γ-C₂S to β-C₂S occurs. At 280°C, tobermorite loses its water of hydration and dehydrates.

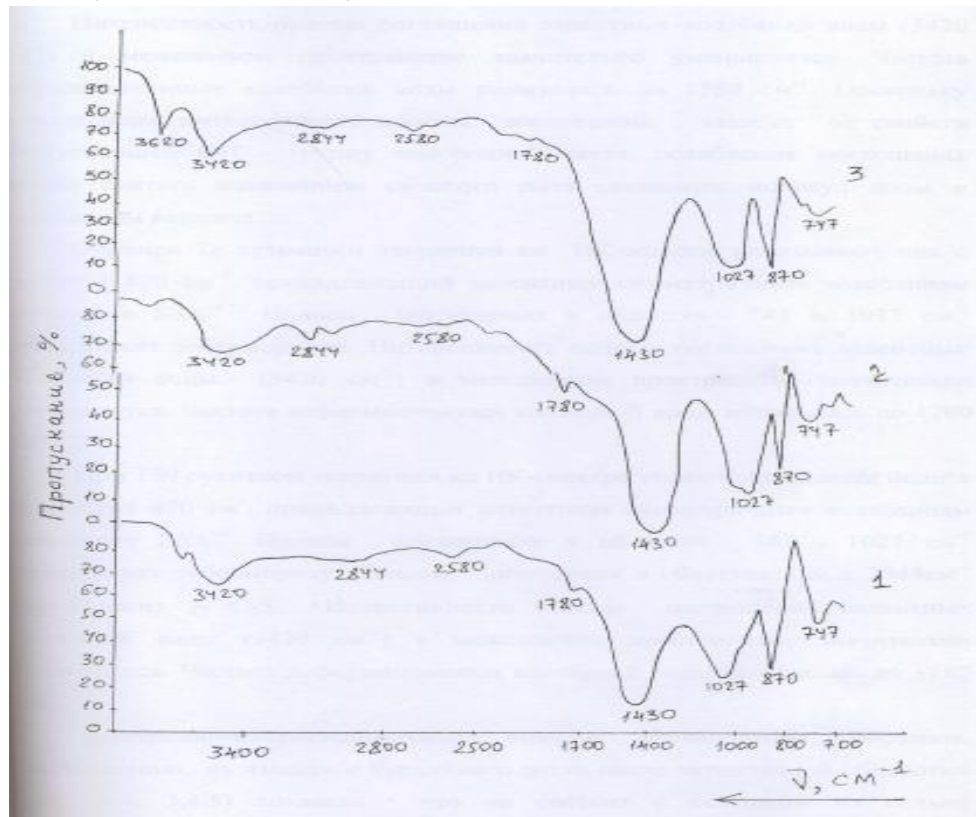


Fig. 2. IR spectra of a mixture of 75% Nukus dune sand + 25% Aktau lime processed in an autoclave at a pressure of 0.8 MPa after 1) -7 days: 2) -28 days: 3) -180 days of hardening

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The IR spectra of the 7-day cured samples after autoclaving (Fig. 3) show a band with a frequency of 870 cm^{-1} , belonging to the symmetric stretching vibrations of the SiO_4^{4-} tetrahedron.

The intensity of the absorption band corresponding to the stretching vibrations of water (3420 cm^{-1}) in the interlayer space significantly decreased. The frequency of the deformation vibrations of water decreased to 1780 cm^{-1} . Since the integrated intensity of the absorption band depends on the properties of the hydrogen bond perturbing the OH group, the weakening of the absorption can be considered a change in the force field of the bound water molecules in the sand-lime brick.

The IR spectrum of the 28-day-cured samples shows a peak at 870 cm^{-1} , belonging to the symmetric stretching vibrations of SiO_4^{4-} tetrahedra. The absorption bands in the regions of 747 and 1027 cm^{-1} belong to tobermorite. The intensity of the absorption band corresponding to the stretching vibrations of water (3420 cm^{-1}) in the interlayer space significantly decreases. The frequency of the deformation vibrations of water decreased to 1780 cm^{-1} .

After 180 days of curing, the IR spectrum also exhibits a band at 870 cm^{-1} , attributed to the symmetrical stretching vibrations of SiO_4^{4-} tetrahedra. Absorption bands at 580 and 2844 cm^{-1} correspond to $\gamma\text{-C}_2\text{S}$. The intensity of the absorption band corresponding to the stretching vibrations of water (3420 cm^{-1}) decreases significantly in the interlayer space. The frequency of the deformation vibrations of water decreased to 1780 cm^{-1} .

Electron micrographs of autoclaved lime and dune sand samples revealed that they consist primarily of heavily corroded fine quartz grains surrounded by fibrous, randomly distributed calcium hydrosilicate formations. The refractive index of the hydrosilicate is $N_{cp} = 1.530\text{-}1.536$. Single plates of calcium oxide hydrate $\text{Ca}(\text{OH})_2$ are present. It is a typical portlandite. Measurements in immersion liquids revealed optical constants of $N_q = 1.580$; $N_p = 1.560$. Brown, opaque gel-like products with a refractive index of $N_{cp} = 1.460$ are occasionally

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encountered. Such a low index is characteristic only of SiO_2 gel. The presence of SiO_2 and $\text{Ca}(\text{OH})_2$ gel in the same sample, along with their reaction product—calcium silicate hydrate—indicates a higher dissolution rate for the silica component compared to the reaction rate between it and calcium oxide hydrate. Thus, it must be concluded that virtually all the lime used during hydration of the experimental mixtures is used to achieve plasticity in the mixture, which is crucial for improving brick molding, as well as during autoclaving for chemical interaction with silicon, iron, and aluminum oxides present in the dune sands. However, the portion of the lime that plasticizes the mixture ultimately calcines after hardening.

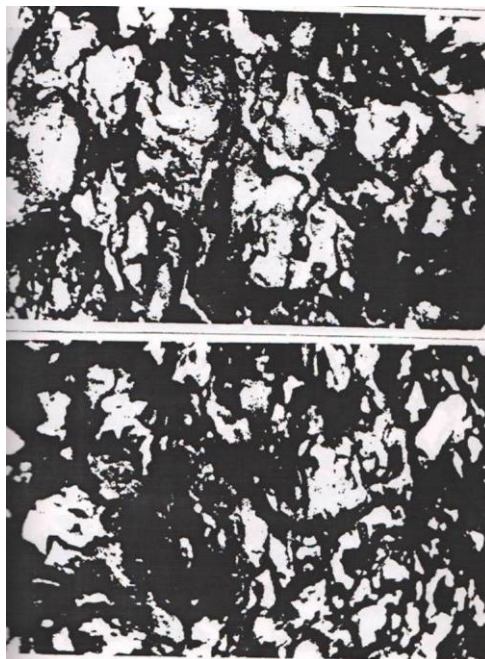


Fig. 3. Electron micrographs of samples after autoclave treatment (x12500). 1. Nukus dune sand + Aktau slaked lime; Nukus dune sand + Dzhumurtau slaked lime.

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