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ANALYSIS OF BUILDING CERAMICS PRODUCTS AND DEVELOPMENT OF RECOMMENDATIONS

Marifova Sevara Dilmurod qizi
Student, Materials Science and Chemical Engineering,
Andijan State Technical Institute
e-mail: sevara20021007@gmail.com

Abstract

This article provides a comprehensive analysis of the composition, properties and practical application efficiency of building ceramic products. In the course of the research, the physical-mechanical, thermal and chemical properties of ceramic materials are studied, and factors affecting their quality indicators are identified. The advantages and disadvantages of ceramic products produced using modern technologies are assessed. Scientific and practical recommendations are also developed to improve product quality and improve economic efficiency. The results obtained serve to expand the possibilities of effective use of ceramic materials in the construction industry and are of great importance in optimizing industrial production processes.

Keywords

building ceramics, brick, ceramic tile, raw material, firing process, mechanical strength, water absorption, thermal conductivity, density, test methods, technology, industrial production, quality control, mineral composition, microstructure, deformation, environmental safety, energy efficiency, innovation, standardization

Introduction

Ceramic products occupy an important place in the building materials industry. Ceramic materials have been used by mankind since ancient times and have not lost their importance today [1]. Especially in modern construction, the demand for ceramic products is increasing due to the need for high strength, long service life and environmental safety [2]. Building ceramic products include bricks, ceramic tiles, roofing materials and special technical ceramics. These products are distinguished by the fact that they are made from natural raw materials and are considered environmentally friendly. The main properties of ceramic materials depend on their mineral composition, production technology and firing process [3]. Therefore, the scientific analysis of building ceramic products is one of the urgent issues.

Energy efficiency, thermal insulation and economic efficiency are important factors in modern construction [4]. Ceramic products are one of the materials that can meet these requirements, and their microstructure and porosity directly affect the heat retention properties. However, improper production technology or the use of poor-quality raw materials can lead to a decrease in product strength, increased water absorption and a shortened service life. Therefore, this article analyzes the main indicators of building ceramic products and develops recommendations for their improvement. The results of the study will serve to produce high-quality and efficient products in the construction industry.

Materials and methods

In the course of the research, a complex of laboratory tests was organized to determine the main physical and mechanical properties of building ceramic products [5]. These tests were

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aimed at determining the quality indicators that meet modern construction requirements, among which such important parameters as density, compressive strength, water absorption and thermal conductivity were separately studied. Widely used bricks and ceramic tiles were selected as the object of the research, since they are the most commonly used materials in construction. The samples were prepared in standard sizes, and each of them was controlled at different stages of the technological process. The pressing process was carried out under high pressure, which achieved densification of the internal structure of the products. The firing process was carried out in special furnaces at a precisely defined temperature regime. A gradual increase in temperature plays an important role in forming the internal structure of the material. At the same time, the mass, volume and degree of deformation of the products were measured at each stage. This served to ensure the accuracy of the results obtained later. During the study, laboratory conditions were strictly controlled, minimizing the influence of external factors.

The process of selecting raw materials was also one of the important stages of the research. Clay from various deposits was used as the main component, since clay is the main component of ceramic products. The degree of plasticity, mineral composition and moisture capacity of the clay were tested, and its technological properties were evaluated. Kaolin was added as an additional component, which served to increase the whiteness and strength of the product. In addition, mineral additives such as quartz sand and feldspar were used, which ensure the structural stability of the product. The proportion of each component was calculated separately, and mixtures were prepared in different proportions. Samples prepared on the basis of these mixtures were compared, and an attempt was made to determine the most optimal composition. In this process, the chemical composition of the raw materials was also determined using laboratory analyzes, and the amount of oxides in it was studied. This made it possible to predict the chemical reactions that occur during the firing process. As a result, the relationship between the composition of the raw materials and the properties of the product was determined, and scientifically based conclusions were drawn.

In the second stage, the microstructure of the prepared ceramic samples was studied in depth. For this, modern electron microscopes were used to analyze the internal structure of the material with high precision. Through microstructural analysis, the degree of porosity, the strength of the intergranular bond, and the formation of crystal phases were determined. The degree of porosity directly affects the thermal and moisture properties of the material, therefore, determining its optimal value is important. Intergranular bonding determines the mechanical strength of the material, that is, the stronger the bond, the higher the durability of the material. During the study, samples prepared based on mixtures of different compositions were compared and differences between their microstructures were identified. In addition, the effect of firing temperature on the microstructure was also studied separately. It was observed that the crystal phases were fully formed in samples fired at high temperatures, while samples fired at low temperatures had a relatively looser structure. Based on these results, it was possible to determine the optimal firing temperature and time regime.

At the third stage, the thermal and physical properties of ceramic products were analyzed in depth. The thermal conductivity index was determined using special laboratory equipment, and the energy efficiency of the material was assessed. This indicator is especially important in modern construction, as it determines the degree of heat retention or release inside the building. According to the results of the study, samples with high porosity have low thermal conductivity, which is more effective for thermal insulation. At the same time, samples with high density were found to be mechanically strong, but have higher thermal conductivity. In addition, the level of water absorption was also studied separately, and it was found that it directly affects the frost resistance of the material. Products with low water absorption retain their properties even in cold climates. Based on the results obtained at this stage, the optimal areas of application of materials were identified and recommendations were developed for their use in various construction conditions.

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At the fourth stage, all experimental results obtained were analyzed using statistical methods. Statistical indicators such as mean values, variance, standard deviation, and confidence interval were calculated. This made it possible to assess the accuracy and reliability of the experimental results. Graphs and diagrams were drawn up for each indicator, through which the results were visually represented. As a result of statistical analysis, the relationship between various parameters was determined and regression models were constructed. Using these models, it was possible to forecast future production processes. In addition, the optimal composition and technological regimes were determined, and scientific and practical recommendations were developed on their basis to increase production efficiency. At the end of the study, the results obtained were summarized and their application in the construction industry was assessed. Thus, this study serves as an important scientific basis for improving building ceramic products and increasing their quality.

Table 1. Main properties of ceramic products

Indicator	All	Tile
Density (kg/m³)	1600–1800	2000–2200
Strength (MPa)	10–25	25–40
Water absorption (%)	8–15	3–8
Thermal conductivity	0.5–0.7	0.8–1.2

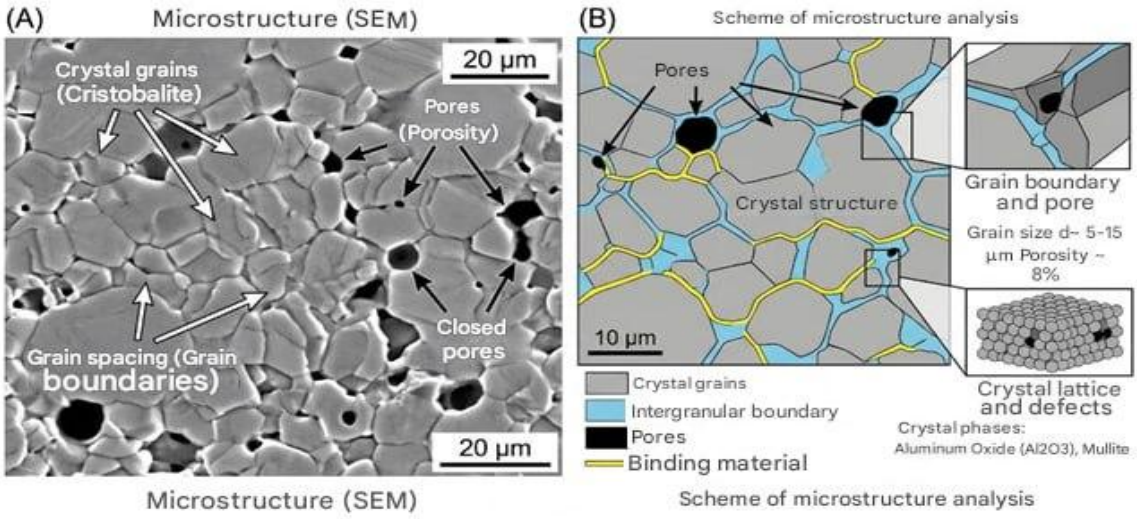

Figure 1. Microstructure of a ceramic product (pores and crystal structure)

Result and discussion

The results of the study showed that the quality indicators of ceramic products depend mainly on the composition of the raw materials and the firing mode. With increasing density, strength also increases, but thermal insulation properties decrease. Therefore, it is important to find the optimal balance. During the study, it was found that samples fired at high temperatures had high strength, but their porosity decreased.

The second important result is that the reduction in water absorption increases the service life of the material. Products with low water absorption also perform well in cold climates. At the same time, it was found that the properties of the product can be improved by adding

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additional mineral substances to the composition. For example, the addition of kaolin increases the strength of the material.

Analyses have shown that ceramic products produced using modern technologies have higher quality indicators than traditional products, which allows for increased energy efficiency in construction.

Table 2. Comparison of products with different ingredients

Content type	Stability	Water absorption
Plain clay	Average	High
Kaolin added	High	Past
With mineral additives	Very high	Very low

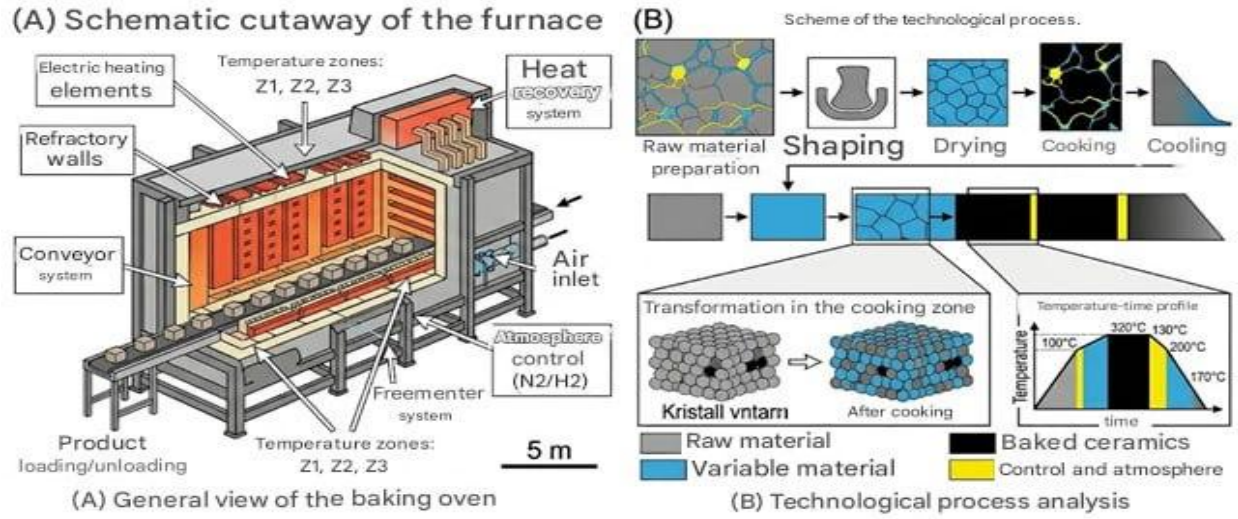

Figure 2. ceramic product firing kiln and technological process diagramm

Conclusion

Based on the conducted research, it can be concluded that the quality of building ceramic products directly depends on their composition, production technology and firing mode. By choosing the optimal composition, the mechanical strength, water absorption and thermal properties of the product can be significantly improved. The results of the research showed that using modern technologies, it is possible to produce high-quality and energy-efficient ceramic products. At the same time, ensuring environmental safety is also important. In the future, scientific research should be continued and new innovative materials should be developed. This will serve the further development of the construction industry.

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