IMPROVEMENT OF TECHNOLOGY FOR INCREASING THE SERVICE LIFE OF OPERATIONAL PROPERTIES OF BUILDING CERAMICS

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Annotation: Improving the service life of the operational properties of building ceramics is one of the important scientific and technical issues today. This study examines technologies for enhancing the mechanical strength, thermal resistance, and environmental stability of ceramic materials. The research analyzes ways to improve the strength and durability of ceramics by optimizing raw material composition, using innovative binders and modifiers, and applying modern heat treatment methods. The results contribute to developing practical recommendations for improving the quality of building ceramic products and extending their service life.

Keywords: Building ceramics, operational properties, service life, strength, thermal resistance, environmental stability, raw material composition, binders, modifiers, heat treatment, mechanical properties, durability, innovation, technological improvement, building materials, quality control, physico-chemical processes, energy efficiency, innovative methods, environmental safety.

1. Introduction

Building ceramics is one of the widely used products in the construction materials industry today, with its strength, durability, and environmental safety being its main advantages. However, various external factors, including moisture, sudden temperature changes, chemical exposure, and mechanical loads, can negatively affect the operational properties of ceramic products. Therefore, increasing the service life of building ceramics and improving its physical, mechanical, and thermal properties is an important scientific and technological issue. This study focuses on investigating innovative technologies aimed at enhancing the durability of building ceramics. In particular, aspects such as optimizing the raw material composition, using new types of binders and modifiers, and applying advanced heat treatment methods are analyzed. The research findings serve to implement efficient technologies in the production of building materials, improve product quality, and enhance operational properties. Consequently, ensuring the long-term durability of building ceramics will contribute to efficiency and environmental sustainability in the construction industry.

2. Research and methods

This study aims to analyze and improve technologies that enhance the operational properties of building ceramics and increase its service life. The research focuses on improving the physical, mechanical, and thermal characteristics of building ceramics by optimizing raw material composition, using innovative binders and modifiers, and employing advanced heat treatment methods. The study is based on experimental and theoretical analysis methods. In experimental research, various raw material compositions, binders, and modifiers were used to assess their impact on the mechanical strength, water absorption, and thermal resistance of ceramic materials. The tests were conducted in laboratory conditions following standard norms. Additionally, modern physico-chemical analysis methods, including X-ray diffraction (XRD), scanning electron microscopy (SEM), and thermogravimetric analysis (TGA), were used to study compositional changes and thermal stability of materials. Based on experimental results, scientifically grounded recommendations were developed to increase the service life of building ceramics. These methods resulted in optimal technological solutions aimed at improving the strength and operational properties of building ceramics. The findings are expected to have practical significance in ensuring quality and environmental stability in the construction materials industry.

Figure 1. Ceramic Products

Figure 2. Ceramic Products

3. Results and discussion

The research results demonstrated that optimizing the raw material composition and using innovative binders are effective methods for improving the operational properties of building ceramics. Experimental tests showed that samples containing modifiers exhibited higher mechanical strength and thermal resistance compared to regular ceramics. In particular, special additives reduced the water absorption rate, enhancing the long-term serviceability of the material. Furthermore, advanced heat treatment technologies, including optimized firing regimes, contributed to the improvement of the microstructure of ceramics. X-ray diffraction (XRD) and scanning electron microscopy (SEM) analyses revealed the formation of a uniformly distributed dense structure in ceramics, increasing their mechanical durability. The discussion of results suggests that the proposed technological solutions contribute to increasing the service life of building ceramics, ensuring its environmental stability, and reducing energy consumption in production. Based on the research findings, scientifically based recommendations were developed for manufacturers of building materials, which will help improve efficiency in practice.

Table 1. Characteristics of Building Ceramics

Indicator	Description
Main raw materials	Clay, sand, feldspar, kaolin, limestone
Production stages	Raw material preparation, shaping, drying, firing
Mechanical strength	Resistant to high pressure and loads
Thermal resistance	Withstands temperature variations
Water absorption rate	3–15% (depending on type)
Environmental safety	Made from natural raw materials, non-toxic
Thermal conductivity	Low (good thermal insulation)
Types	Brick, tile, facing brick, lightweight ceramics
Application areas	Building walls, interior and exterior finishing, pavement coverings
Service life	50–100 years (depending on operating conditions)

4. Conclusion

This study is aimed at improving the operational properties and increasing the service life of building ceramics. The research findings indicate that optimizing raw material composition, using innovative binders and modifiers, and employing advanced heat treatment technologies enhance the strength and thermal resistance of ceramic materials. Experimental results demonstrated that these methods reduce water absorption rates and significantly improve material durability. The analyses confirmed that modern physico-chemical research methods (XRD, SEM, TGA) allow for an in-depth study and optimization of the microstructure of ceramic materials, which is crucial for ensuring their long-term operation. Overall, the proposed technological approaches contribute to improving quality, enhancing energy efficiency, and strengthening environmental safety in the building materials industry. Based on the research findings, practical recommendations were developed for manufacturers, enabling further improvement of building ceramic products. Therefore, the research results can be widely applied in practice.

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