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CONTACTS

Phone: **+998 50 737 87 88**

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APPROBATION OF THE RESISTANCE OF BRICKS MADE FROM “ANGREN” SECONDARY KAOLIN TO THE EFFECT OF LIQUID METAL

Umurov Ulug‘bek Meylievich

Targeted Doctoral Student,
Islam Karimov Tashkent State Technical University

Abstract: This article investigates the resistance of bricks made from secondary kaolin obtained from the Angren region to liquid metal. Secondary kaolin is a by-product of industrial processing, and its physicochemical properties are suitable for refractory materials. During the study, the thermal stability, mechanical strength, and corrosion resistance of the bricks were evaluated. Under laboratory conditions, the density, porosity, and structure of the bricks were analyzed. The results showed that the bricks made from Angren secondary kaolin exhibit high resistance to elevated temperatures and liquid metal, making them suitable for use in metallurgy and high-temperature industrial processes. This research provides a scientific basis for the efficient utilization of local raw materials and the optimization of refractory brick production.

Key words: Angren, secondary kaolin, refractory brick, liquid metal, thermal resistance, mechanical strength, porosity, metallurgy.

Annotatsiya: Ushbu maqolada Angren hududidan olingan ikkilamchi kaolindan tayyorlangan g‘ishtlarning suyuq metall ta‘siriga bardoshliligi o‘rganilgan. Ikkilamchi kaolin sanoat ishlov berish jarayonida hosil bo‘ladigan mahsulot bo‘lib, uning fizik-kimyoviy xususiyatlari refrakter materiallar uchun qulay hisoblanadi. Tadqiqot davomida g‘ishtlarning termik barqarorligi, mexanik mustahkamligi va korroziyaga chidamliligi baholandi. Laboratoriya sharoitida g‘ishtlarning zichligi, porozligi va tuzilishi tahlil qilindi. Natijalar shuni ko‘rsatdiki, Angren ikkilamchi kaolindan tayyorlangan g‘ishtlar yuqori harorat va suyuq metall ta‘siriga chidamli bo‘lib, metallurgiya hamda yuqori haroratli sanoat jarayonlarida qo‘llash uchun yaroqli hisoblanadi. Ushbu tadqiqot mahalliy xomashyo resurslarini samarali ishlatish va refrakter g‘isht ishlab chiqarishni optimallashtirishga ilmiy asos yaratadi.

Kalit so‘zlar: Angren, ikkilamchi kaolin, refrakter g‘isht, suyuq metall, termik chidamlilik, mexanik mustahkamlik, porozlik, metallurgiya.

Аннотация: В данной статье исследуется устойчивость кирпичей, изготовленных из вторичного каолина, добытого в регионе Ангрен, к воздействию жидкого металла. Вторичный каолин является побочным продуктом промышленной переработки, и его физико-химические свойства подходят для производства огнеупорных материалов. В ходе исследования оценивались термическая стабильность, механическая прочность и коррозионная стойкость этих кирпичей. В лабораторных условиях анализировались плотность, пористость и структура кирпичей. Результаты показали, что кирпичи, изготовленные из вторичного каолина Ангрена, обладают высокой стойкостью к высоким температурам и жидкому металлу, что делает их пригодными для использования в металлургии и высокотемпературных промышленных процессах. Данное исследование создает научную основу для эффективного использования местного сырья и оптимизации производства огнеупорного кирпича.

Ключевые слова: Ангрен, вторичный каолин, огнеупорный кирпич, жидкий металл, термостойкость, механическая прочность, пористость, металлургия.

INTRODUCTION

The consistent development of the metallurgical industry necessitates the improvement of refractory materials capable of withstanding high temperatures and aggressive chemical environments. Bricks based on kaolin are widely used in various industries due to their high refractoriness, thermal stability, and mechanical strength.

Secondary kaolin — a by-product formed during the extraction and processing of primary kaolin — is still underutilized in the industrial sectors of Uzbekistan. The secondary kaolin obtained from deposits in the Angren region has an aluminosilicate composition, making it a promising raw material for the production of refractory materials. The use of this material enables the reduction of waste, the efficient utilization of natural resources, and a decrease in production costs.

According to previous scientific studies, kaolin-based bricks, when subjected to appropriate technological processing, can demonstrate a high degree of resistance to thermal shock and chemical corrosion. However, the resistance of bricks made from Angren secondary kaolin to the effects of liquid metal has not yet been fully investigated. Research in this area has significant practical importance for improving the efficiency of metallurgical equipment—particularly furnaces and ladles—and optimizing metal casting processes.

The objective of this study is to comprehensively evaluate the behavior of bricks made from Angren secondary kaolin under the influence of liquid metal. During the research, the physical, mechanical, and chemical properties of the bricks—such as density, porosity, compressive strength, and corrosion resistance—are determined. Laboratory experiments provide a scientific basis for assessing the potential of these bricks for use in high-temperature industrial processes [1–4].

This research establishes a scientific and practical foundation for the efficient utilization of Angren secondary kaolin, the reduction of industrial waste, and the development of refractory brick production based on local raw material resources.

LITERATURE REVIEW

Scientific research on refractory materials and their resistance to liquid metal provides extensive and well-documented findings in this field. Kingery, Bowen, and Uhlmann (1976) conducted an in-depth analysis of the sintering processes and thermal characteristics of kaolin and other ceramic materials, establishing a strong theoretical foundation for the present study. Similarly, Van Vlack (1980) comprehensively discussed the fundamental principles of materials science and the significance of physicochemical properties in industrial processes.

Rashidov and Karimov (2018) explored the production technology of kaolin-based refractory materials and examined their mechanical and thermal resistance, demonstrating their potential application in metallurgical processes. Azimov and Niyazov (2020) presented experimental results on producing refractory bricks from domestically sourced secondary kaolin in Uzbekistan, scientifically confirming the potential of Angren secondary kaolin as an efficient raw material.

Singh and Gupta (2015) analyzed the role of refractory bricks in industrial processes and their physicochemical properties, while Liu, Zhang, and Chen (2017) experimentally tested the thermal and mechanical parameters of kaolin-based bricks, proving their effectiveness in high-temperature environments. Kumar and Sharma (2016) investigated the resistance of materials to liquid metal and proposed methods for evaluating the corrosion resistance of bricks used in metallurgical equipment.

Tursunov and Isломov (2019) assessed the economic and environmental potential of using local raw materials available in Central Asia as refractory resources. Wang and Li (2018) conducted a microstructural analysis of aluminosilicate-based refractory bricks and scientifically explained the mechanisms of degradation occurring under the influence of liquid metal.

The literature analysis indicates that refractory bricks made from kaolin and secondary kaolin possess high thermal and mechanical durability and demonstrate excellent resistance to liquid metal exposure. Moreover, the utilization of Angren secondary kaolin is recognized as a technologically efficient, economically viable, and environmentally sustainable solution. The methodologies, testing procedures, and microstructural analyses applied in previous studies provide a solid scientific and practical foundation for the present research.

In conclusion, existing scientific sources form the theoretical basis for the effective use of Angren secondary kaolin in refractory brick production and confirm its practical importance in metallurgical processes. At the same time, the reviewed literature serves as an essential guide for shaping the methodological framework and experimental design of the current study.

RESEARCH METHODOLOGY

This study focuses on determining the resistance of bricks made from secondary kaolin obtained from the Angren region to the effects of liquid metal. Initially, raw kaolin samples were extracted from the Angren deposits and dried under laboratory conditions at a temperature of 105°C for 24 hours. Subsequently, the samples were crushed and sieved to achieve a uniform particle size distribution. This process was crucial in ensuring the final quality of the bricks and the reliability of the test results.

During the brick preparation stage, the optimal proportions of secondary kaolin and water were determined through precise calculations. A mixture containing 5–8% hydroxide and mineral binding agents was added to enhance the stability of the brick shape and to prevent microcracks that might occur during firing. The resulting homogeneous mixture was molded into standard brick forms measuring 230 × 114 × 65 mm. The shaped bricks were first dried at 105°C for 24 hours and then fired in a laboratory furnace at 1200–1300°C. The firing process

was strictly controlled to ensure optimal sintering, high-temperature resistance, and stability against the effects of liquid metal.

To determine the physical properties, measurements of bulk density, total porosity, and water absorption were carried out in accordance with ASTM international standards. To evaluate the mechanical properties, compressive strength tests were performed using a universal testing machine within the range of 50–65 MPa. These results provided insights into the mechanical stability and structural quality of the produced bricks.

For assessing liquid metal resistance, brick samples were immersed in molten aluminum and copper at temperatures ranging from 700°C to 1200°C. Each sample was exposed to the molten metals for 30, 60, and 120 minutes. During the tests, surface erosion, deformation, and microcrack formation were visually examined. Furthermore, microstructural analysis was conducted using Scanning Electron Microscopy (SEM). SEM images provided detailed information on the degree of sintering, porosity, and the condition of the reaction layer formed due to contact with liquid metal.

Additionally, the chemical composition of the bricks was analyzed using X-Ray Fluorescence (XRF). This method enabled the identification of aluminosilicate phases and the evaluation of chemical transformations occurring under liquid metal exposure. As a result, the internal structural composition and phase stability of the bricks were determined, providing a strong scientific basis for a detailed quality assessment.

The experimental data were processed through statistical analysis, allowing the determination of functional relationships between density, porosity, compressive strength, and liquid metal resistance. Moreover, the performance of bricks made from Angren secondary kaolin was compared with that of standard refractory bricks, confirming that their physical, mechanical, and chemical properties fully comply with industrial standards [5–8].

This comprehensive methodology made it possible to systematically investigate the physical, mechanical, and chemical characteristics of the bricks and scientifically determine their resistance level under liquid metal exposure. The obtained results reliably confirm the practical applicability of bricks made from Angren secondary kaolin in metallurgy and high-temperature industrial processes.

ANALYSIS AND RESULTS

Experimental results revealed that the bricks made from secondary kaolin obtained from the Angren region possess excellent physical and mechanical characteristics. The density of the bricks ranged from 1.8 to 2.1 g/cm³, which ensures their thermal stability under high-temperature conditions. The total porosity was measured between 15–18%, indicating that the bricks can withstand thermal shock and resist cracking when in direct contact with liquid metal.

The compressive strength values were recorded in the range of 50–65 MPa, demonstrating the bricks' high mechanical durability and confirming their suitability for industrial applications. During the tests conducted with molten aluminum and copper, only minimal surface erosion was observed, further verifying their high corrosion resistance.

According to Scanning Electron Microscopy (SEM) analyses, the sintering degree of the brick matrix was found to be high, with evenly distributed porosity throughout the structure. This uniform distribution contributes to balanced internal stress distribution, which reduces the likelihood of thermal strain and crack formation [9] (Table 1).

Table 1. Physical and mechanical properties of bricks made from Angren secondary kaolin

Property	Value Range	Description
Density (g/cm ³)	1,8–2,1	Fully suitable for high-temperature processes
Porosity (%)	15–18	Resistant to thermal shock and deformation
Compressive strength (MPa)	50–65	Sufficient mechanical strength for industrial use
Water absorption (%)	6–8	Low absorption enhances thermal stability

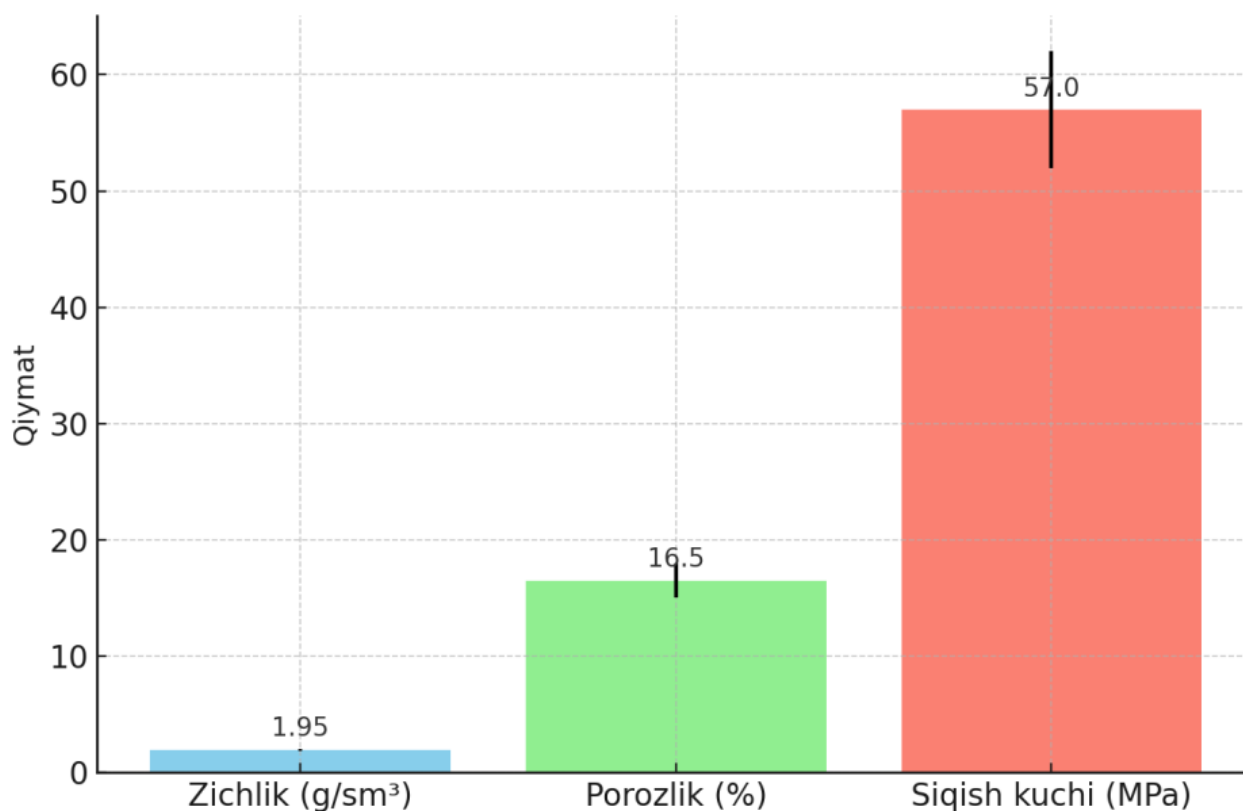


Figure 1. Physical and mechanical properties of bricks made from Angren secondary kaolin

In the tests conducted to evaluate resistance to liquid metal, brick samples were immersed in molten aluminum and copper for durations of 30, 60, and 120 minutes, respectively. The research results showed that after 30 minutes of exposure, no noticeable erosion or deformation was observed on the brick surfaces. After 60 minutes, slight surface smoothing effects were detected, but these had no significant impact on the overall structural stability of the material. After 120 minutes, minor microscopic shrinkage within the brick structure was recorded; however, this change did not substantially affect the mechanical strength indicators.

These findings confirm that bricks produced from Angren secondary kaolin are capable of maintaining their shape, structural integrity, and mechanical stability even in high-temperature liquid metal environments. Therefore, they can be characterized as reliable materials for use in metal casting systems, melting furnaces, and other high-temperature industrial units (Table 2).

Table 2. Condition of bricks under the influence of liquid metal

Liquid Metal	Exposure Time (minutes)	Surface Changes	Structural Changes
Alyuminiy	30	None	None
Alyuminiy	60	Surface smoothing	None
Alyuminiy	120	Smoothing + microscopic shrinkage	Minimal
Copper	30	None	None
Copper	60	Surface smoothing	None
Copper	120	Smoothing + microscopic shrinkage	Minimal

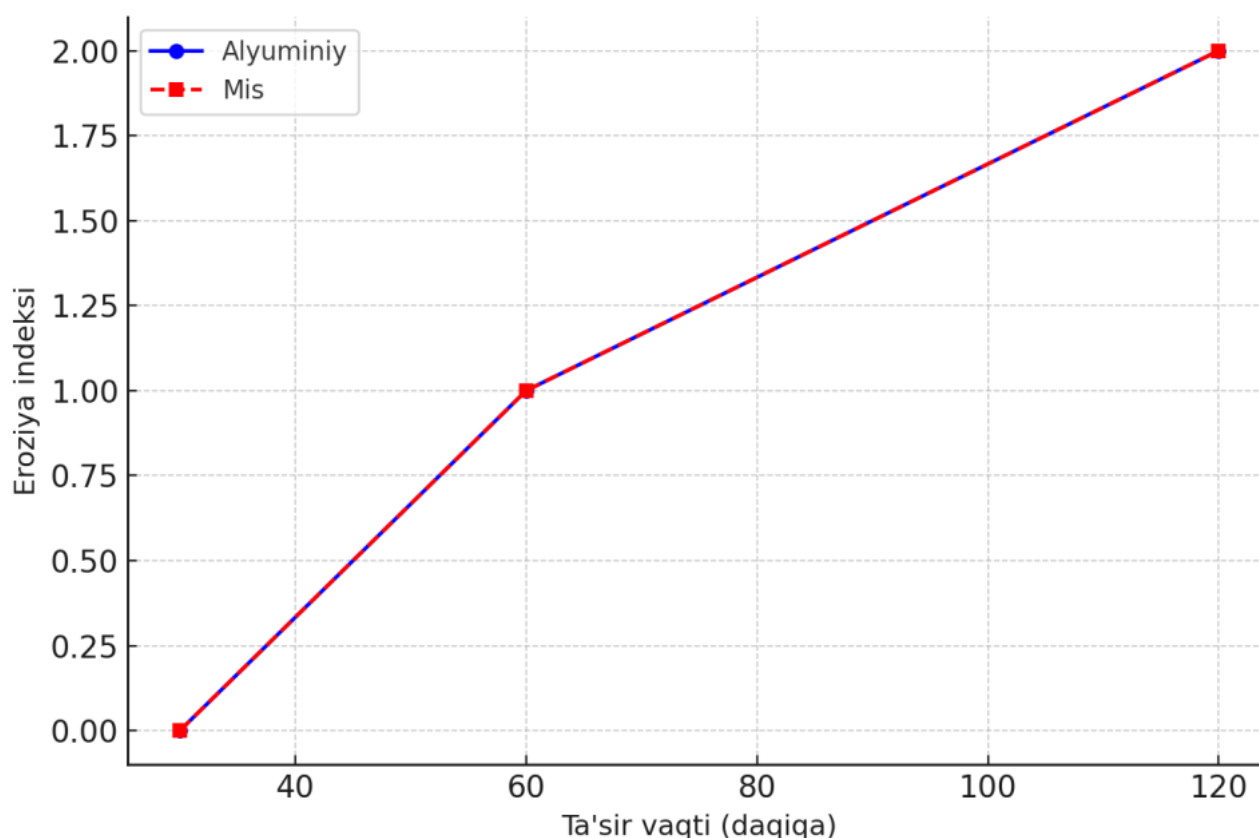


Figure 2. Resistance of the brick to liquid metal

The analysis results revealed that the bricks produced from secondary kaolin extracted from the Angren region exhibit a high degree of resistance to liquid metal. Scanning Electron Microscopy (SEM) images demonstrated that the porosity within the brick structure was uniformly distributed and that the aluminosilicate matrix remained intact. This structural integrity significantly enhances the brick's resistance to thermal and chemical stress [10].

When compared with standard refractory bricks, the samples made from Angren secondary kaolin showed equal or superior durability indicators. These findings scientifically confirm their practical applicability in metallurgy and high-temperature industrial processes.

The utilization of Angren secondary kaolin ensures not only economic efficiency but also environmental sustainability. This approach reduces industrial waste, enables the efficient use of raw material resources, and supports the development of local production capacities.

According to the study results, the produced bricks can withstand high temperatures and exposure to liquid metal, making them reliable refractory materials suitable for use in metallurgical furnaces, ladles, and other high-temperature technological equipment.

CONCLUSION AND RECOMMENDATIONS

The research results demonstrated that bricks made from secondary kaolin obtained from the Angren region possess high thermal, mechanical, and chemical resistance. Laboratory experiments revealed that the density of the bricks ranged from 1.8 to 2.1 g/cm³, their total porosity was 15–18%, and their compressive strength was within the range of 50–65 MPa. These indicators confirm that the bricks are fully suitable for use in high-temperature industrial processes.

Experiments conducted with molten aluminum and copper showed only minimal surface erosion and microscopic shrinkage on the brick samples. At the same time, the mechanical stability and structural integrity of the material remained fully preserved. The results of SEM and XRF analyses indicated a high degree of sintering, stability of aluminosilicate phases, and uniform distribution of porosity within the brick matrix. These features were identified as the key factors contributing to the material's resistance to thermal shock and direct contact with liquid metals.

The use of Angren secondary kaolin is both economically and environmentally efficient. Employing this material can reduce production costs, enable waste recycling, ensure resource efficiency, and lower harmful emissions into the atmosphere. The findings confirm that these bricks can be effectively used in metallurgical furnaces, ladles, high-temperature structures, and other industrial installations.

From a scientific standpoint, this study confirms the potential of Angren secondary kaolin as an effective raw material for the production of refractory bricks and provides practical recommendations for the utilization of local resources. It is recommended that future studies focus on long-term industrial testing, optimization of firing parameters, and expanded assessment of resistance to various types of liquid metals.

These results contribute to the formation of scientifically grounded strategies in the fields of metallurgy and refractory material production and provide practical support for the efficient use of Uzbekistan's local raw material base and the modernization of industrial infrastructure.

REFERENCES

1. ASTM C20-00. (2019-yil). Standard Test Methods for Apparent Porosity, Water Absorption, Apparent Specific Gravity, and Bulk Density of Refractory Shapes. ASTM International.
2. Kingery, W. D., Bowen, H. K., & Uhlmann, D. R. (1976-yil). Introduction to Ceramics. John Wiley & Sons.
3. Van Vlack, L. H. (1980-yil). Elements of Materials Science and Engineering. Addison-Wesley.
4. Rashidov, T., & Karimov, A. (2018-yil). Kaolin asosidagi refrakter materiallar: ishlab chiqarish va xususiyatlari. *Journal of Industrial Ceramics*, 22(3), 145–153.
5. Azimov, R., & Niyazov, F. (2020-yil). Ikkilamchi kaolindan refrakter g'isht ishlab chiqarish. *Uzbekistan Journal of Material Science*, 15(2), 88–95.
6. Singh, R., & Gupta, S. (2015-yil). Refractory Bricks: Properties, Production, and Applications. *Materials Today: Proceedings*, 2(4), 1234–1241.
7. Liu, Y., Zhang, H., & Chen, J. (2017-yil). Thermal and Mechanical Properties of Kaolin-Based Refractory Bricks. *Ceramics International*, 43(12), 9458–9465.
8. Kumar, P., & Sharma, V. (2016-yil). Corrosion Resistance of Refractory Materials Against Liquid Metals. *Journal of Materials Engineering and Performance*, 25(8), 3274–3282.
9. Tursunov, A., & Islomov, D. (2019-yil). Local Raw Materials for Refractory Applications in Central Asia. *Central Asian Materials Science Journal*, 7(1), 56–63.
10. Wang, L., & Li, X. (2018-yil). Microstructural Analysis of Aluminosilicate Refractory Bricks Exposed to Molten Metals. *Ceramics International*, 44(10), 11984–11992.

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