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Evaluation Of Production Technologies And Market Potential Of Magnesial Binders In Uzbekistan

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Abstract: This paper provides a comprehensive assessment of the current condition and development trajectory of the magnesial binder industry in the Republic of Uzbekistan. The study examines the country's raw material potential, including reserves of magnesite- and dolomite-based minerals, and analyzes the technological processes used in the production of caustic magnesite and caustic dolomite. Special attention is given to the quality parameters of locally produced binders, their competitiveness, and their applicability in various sectors of construction, chemical production, and environmental technologies. Existing challenges related to resource utilization, energy efficiency, and modernizations of production facilities are identified. The paper also outlines strategic opportunities for advancing the industry through innovation, improved processing technologies, and expansion of domestic and export markets. Overall, the study highlights the importance of magnesial binders as a promising segment within Uzbekistan's construction material industry and underscores the need for further research and investment to ensure sustainable sectoral growth.

Keywords: Magnesial binders, caustic magnesite, caustic dolomite, raw material base, construction materials, Uzbekistan.

INTRODUCTION:

Magnesial binders represent a distinct group of mineral air-hardening binders obtained through the thermal processing of naturally occurring magnesium-containing rocks. The main types include caustic magnesite and caustic dolomite, which differ from other binders by their unique hardening mechanism based on magnesium salt solutions as activators [1,2].

Caustic magnesite is produced by calcining natural magnesite ($MgCO_3$) at temperatures of 700–850°C, following the reaction:

$MgCO_3 \rightarrow MgO + CO_2$ [3].

Caustic dolomite, in turn, is obtained by calcining natural dolomite ($CaCO_3 \cdot MgCO_3$) at 650–750°C [4].

Magnesial binders exhibit a set of advantageous engineering properties, including high mechanical strength reaching 80–100 MPa after 28 days of curing, rapid setting and hardening, strong adhesion to organic fillers, enhanced elasticity, and superior wear resistance [5,6]. Owing to these characteristics, they are widely used in the production of xylolite floors, fibrolite boards, thermal-insulation materials, artificial marble, decorative composites, and plaster mortars [7,8].

Uzbekistan possesses substantial mineral resources, with more than 2,700 deposits containing around 100 types of raw materials identified across the country [9]. Despite this strong raw-material base, the production of magnesial binders has not yet achieved the level of industrial development observed in other construction-materials sectors [10–15]. Strengthening technological modernization, improving resource utilization efficiency, and expanding application areas remain essential prerequisites for unlocking the sector's full potential.

METHODS

The study was conducted using a comprehensive analytical approach based on scientific and technical documentation, regulatory acts of the Republic of Uzbekistan, and published research on the technology of producing magnesial binders. The methodological framework included several complementary research tools aimed at ensuring the accuracy and reliability of the obtained results.

The research methods comprised:

- Analysis of the regulatory and legal framework, including national standards and governmental documents governing the production and quality control of magnesial binders;
- Geological assessment of the raw material base, carried out in accordance with the methodological guidelines issued in 1998, which provide classification principles, geological evaluation procedures, and criteria for determining the suitability of magnesite- and dolomite-bearing deposits [16];
- Technical–economic and comparative analysis, aimed at evaluating production efficiency, energy consumption, material utilization, and the competitiveness of magnesial binder technologies relative to traditional binders used in Uzbekistan;
- Assessment of raw material requirements, based on the specifications outlined in GOST 1216-87, which regulate mineralogical composition, impurity limits, calcination degree, and physical–chemical indicators necessary for producing high-quality caustic magnesite and caustic dolomite [17].

The combination of these methods made it possible to obtain a holistic understanding of the current state of the magnesial binder industry, identify existing constraints, and outline potential directions for improving production technology and resource utilization efficiency.

RESULTS

Raw Material Base. Within the territory of Uzbekistan, no explored industrial deposits of crystalline magnesite—the primary raw material for producing high-quality caustic magnesite—have been identified. This distinguishes the country from regions such as the Urals (Satka deposit), the Irkutsk region (Savin deposit), and Kazakhstan, where large magnesite resources are concentrated [22].

However, several deposits of dolomites have been documented [19], including:

- Dekhanabad deposit (Kashkadarya region) — a large deposit classified as Group I;
- Gulmamasay deposit (Tashkent region) — small;
- Shorsu deposit (Fergana region) — small.

The chemical composition of Uzbekistan's dolomites typically includes around 20% MgO, 30% CaO, and 45% CO_2, making them suitable for producing caustic dolomite but requiring technological optimization [20].

Technological Condition of the Industry. At present, Uzbekistan does not have specialized industrial facilities for the production of caustic magnesite or caustic dolomite. The technological infrastructure necessary for full-scale production remains underdeveloped.

Key limiting factors include:

1. Absence of high-quality crystalline magnesite deposits, which restricts domestic production of premium-grade binders;
2. Insufficient geological exploration of existing dolomite deposits, leading to incomplete assessment of reserves and quality;
3. Lack of technological equipment, such as calcination furnaces, grinding mills, and controlled heat-treatment systems;
4. Shortage of suitable activators, particularly magnesium chloride hexahydrate ($MgCl_2 \cdot 6H_2O$) and magnesium sulfate heptahydrate ($MgSO_4 \cdot 7H_2O$), which are essential for binder hardening.

Potential Application Areas. Despite the limitations, magnesial binders hold significant potential for use in Uzbekistan's construction materials industry:

1. Flooring systems. Xylolite floors demonstrate high compressive strength (200–300 kg/cm^2 after 28 days), excellent abrasion resistance, and suitability for industrial and public buildings [16–18].
2. Thermal-insulation materials. Fibrolite is particularly relevant for Uzbekistan's climatic conditions due to its low thermal conductivity and mechanical stability [19].
3. Facing and decorative materials. Artificial marble, decorative panels, and magnesial plaster benefit from the binder's elasticity, polishability, and aesthetic finish [18].
4. Special applications. Production of abrasive wheels, sharpening stones, and technical ceramics.

A major limitation is low water resistance, which restricts the use of magnesial materials to indoor environments with a relative humidity not exceeding 60% [12]. Recent studies suggest that incorporating natural silicate fillers into magnesial compositions can significantly improve water resistance and dimensional stability [20].

Regulatory Framework. The development of the magnesial binder industry is influenced by national policies aimed at strengthening the construction materials sector. The Resolution of the Cabinet of Ministers No. PP-4335 dated 23 May 2019 approved measures for the accelerated development of construction materials production in Uzbekistan [10]. Furthermore, the Ministry of Mining Industry and Geology was established in 2022, consolidating regulatory functions and geological exploration activities to support efficient raw material utilization and sectoral growth [21].

DISCUSSION

The study revealed a critical lag in Uzbekistan in the field of magnesial binder production. Unlike Russia, which possesses large industrial deposits such as the Savin and Satka deposits [13], Uzbekistan does not have industrial reserves of high-quality magnesite.

Dolomite deposits, however, may serve as a basis for establishing caustic dolomite production. Although caustic dolomite is inferior in quality to caustic magnesite (compressive strength 10–30 MPa) [22-25], it can still be used in similar application areas.

The key problems identified include dependence on imports, insufficient geological exploration, lack of technological infrastructure, low awareness among construction professionals, and climatic limitations (relative humidity not exceeding 60%).

Prospective directions for development

1. Establishing caustic dolomite production based on the Dekhanabad deposit, followed by technological testing and the development of a feasibility study.

2. Implementing an import-substitution strategy through the production of xylolite floors, fibrolite boards, and artificial marble.

3. Conducting scientific research to develop modified magnesial binders incorporating local silicate materials to improve water resistance.

4. Developing a normative and technical framework, including national standards (O'z DSt) and technical specifications for finished products.

5. Training qualified personnel by introducing specialized educational programs in relevant higher-education institutions.

6. Ensuring technological transfer through studying the experience of Russia, China, and Austria, and establishing international collaboration.

7. Creating favorable economic conditions, such as tax incentives, subsidized loans, and state support initiatives.

CONCLUSIONS

1. Uzbekistan does not possess deposits of crystalline magnesite. However, several dolomite deposits have been identified, including the Dekhanabad, Gulmamasay, and Shorsu deposits.

2. Industrial production of magnesial binders is currently absent in the country, resulting in dependence on imported materials.

3. The potential for application is significant—particularly for wear-resistant flooring, thermal insulation products, and decorative coatings. The country's climatic conditions (low relative humidity) are favorable for the use of magnesial materials.

4. The development of the sector requires detailed geological exploration, the establishment of production facilities, the development of national standards, and the training of qualified specialists.

5. A promising direction is the establishment of caustic dolomite production based on the Dekhanabad deposit, along with the development of blended compositions.

6. The development of this industry aligns with national policies aimed at accelerating the growth of the construction materials sector.

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