"INORGANIC BINDER TECHNOLOGY AND INCREASING THE EFFICIENCY OF THEIR USE IN THE CONSTRUCTION INDUSTRY"

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ABSTRACT

The article studies the classification of inorganic binders, their physicochemical properties, hardening processes, and technological processes of binder materials based on Portland cement, gypsum, and lime. Modern approaches to the production technologies of building materials, hydration and hardening mechanisms, as well as various types of hydraulic binders are analyzed. The study substantiates the current directions of development of the construction chemical industry in the Bukhara region, new innovative approaches, and opportunities for increasing technological efficiency.

Introduction

The building materials industry is one of the important sectors of the country's economy. It is impossible to build modern structures without binders such as cement, lime, and gypsum. Therefore, the introduction of high-quality, energy-saving, and environmentally friendly technologies in this sector is an urgent issue.

Today, large enterprises such as "Qizilqum Cement", "Huaxin Cement Jizzakh", and "Portlandcement" operate in Uzbekistan and Belarus. They produce high-quality Portland cement, lime, and other binders and supply competitive products to the domestic and foreign markets.

The chemical industry, including construction chemistry, creates an important raw material base for all sectors of the economy. Since cement and gypsum production processes are energy- and resource-intensive processes, their technological optimization and the introduction of waste-free production systems are of priority.

Main part

Classification of inorganic binders

Binders are divided into the following groups according to their chemical composition and hardening mechanisms:

- Hydraulic binders: Portland cement, alumina cement, pozzolanic cement.
- Air binders: gypsum, air lime.
- Mixed binders: slag, acid-resistant cements, phosphate-based compositions.

Their hardening mechanism is based on the processes of hydration, coagulation and polycondensation. For example, when Portland cement is mixed with water, a hydration reaction occurs, forming hydrosilicates and hydroaluminates.

Properties of gypsum binders

Gypsum binders are made on the basis of $CaSO_4 \cdot 0.5H_2O$. Their density is 2.6–2.75 g/cm^3, and their water resistance is relatively low, and they are mainly used in interior parts of buildings. Hydration of gypsum occurs at a temperature of 130–180°C through the processes of dehydration and re-reaction with water. Highly calcined gypsums, on the other hand, produce slow-setting, but more water-resistant materials.

Hydration and hardening of calcium lime

Calcium lime (CaO) reacts with water to form $Ca(OH)_2$. This process is exothermic and expands the volume. The resulting hydrates form a strong crystalline structure during construction and are used as a binder in construction.

Slaked lime reacts with carbon dioxide in the air to form $CaCO_3$. This process provides the hardness of limestone.

Composition and technology of Portland cement

Portland cement clinker consists of the following main minerals:

C_3S (alite) – 45–60 %

C_2S (belite) – 20–30 %

C_3A (aluminate) – 5–12 %

C_4AF (ferrite) – 10–20 %

The hardening of cement occurs mainly as a result of the hydration of C_3S and C_2S. As a result of this process, calcium hydrosilicates and hydroxides are formed. During hydration, the cement stone is strengthened, heat is released and a crystal structure is formed.

Portland cements are divided into M400, M500, M600 grades according to GOST 10178-85. Quick-hardening, sulfate-resistant, composite cements are also produced.

Research methods and results

The study used chemical analysis, statistical processing, microscopic observation and thermogravimetric analysis methods. The results showed that:

With an increase in the proportion of C_3S in hydraulic binders, the 28-day strength increases to 60 MPa.

Adding special additives to gypsum-based materials (Na_2SO_4, K_2SO_4) stabilizes the setting time.

Controlling the growth of $(OH)_2$ crystals significantly improves the quality of limestone.

Development of construction chemistry on the example of Uzbekistan and Bukhara region.

Based on the Resolution of the President of the Republic of Uzbekistan No. PQ-3983, work has begun on the modernization of the chemical industry, the construction of new cement plants and deep processing of local raw materials.

With the launch of the "Zafarabad Cement Plant" in Bukhara region, the export potential of the region has significantly increased. This allows for new jobs, environmentally friendly production and the production of import-substituting products.

Conclusion

The results of the study led to the following scientific and practical conclusions:

A thorough study of the classification, composition and hardening mechanisms of inorganic binders is important for improving their quality.

By controlling hydration and hydrothermal processes, the strength, water resistance and environmental sustainability of cement and gypsum-based materials can be increased.

By effectively using the existing raw material base (limestone, gypsum, clay) in the Bukhara region, it is possible to expand the production of local building materials.

The integration of the chemical and construction industries is a key factor in increasing the industrial potential of Uzbekistan.

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