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## Utilization of Technogenic Flotation Waste of Copper–Molybdenum Ores in Portland Cement Production

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### ABSTRACT

The concept of sustainable development in the mining and mineral processing industry is primarily aimed at solving environmental protection problems through the transition to low-waste and waste-free technologies. One of the key approaches involves the utilization of previously accumulated industrial waste as secondary raw materials. This study presents experimental results on the production of Portland cement using flotation waste generated during the beneficiation of copper–molybdenum ores at JSC “Almalyk Mining and Metallurgical Combine.” Thermal activation of flotation waste was carried out in the temperature range of 700–900 °C with an isothermal holding time of 3 h. The results showed that the maximum pozzolanic activity of the flotation waste was achieved at 800 °C. Portland cements produced by joint grinding of clinker, thermally activated mineral additive, and gypsum demonstrated stable technological and mechanical properties and fully complied with the requirements of GOST 31108–2022. The utilization of flotation waste not only improves cement performance but also contributes to environmental protection and resource conservation.

**KEYWORDS:** flotation waste, copper–molybdenum ores, thermal activation, mineral additive, Portland cement, sustainable development.

### Main Part

Large volumes of flotation waste are generated during the beneficiation of copper–molybdenum ores at JSC “Almalyk Mining and Metallurgical Combine.” The flotation process is carried out in mechanical and pneumatic-mechanical flotation machines. During beneficiation, the froth product of the main flotation is subjected to double cleaning, while the chamber product is directed to scavenger flotation. The tailings of scavenger flotation are discharged as waste.

Considering that thermal activation is an effective method for increasing the reactivity of mineral

additives used in Portland cement production, flotation waste of copper–molybdenum ores was thermally treated at temperatures ranging from 700 to 900 °C. Isothermal holding at the final temperature was maintained for 3 h. Experimental results indicated that the highest pozzolanic activity of the flotation waste was achieved at a temperature of 800 °C. Portland cements were produced by joint grinding of clinker, thermally activated flotation waste, and gypsum stone. The obtained cement samples exhibited stable technological properties, including setting time and workability, as well as satisfactory strength characteristics. The results confirmed that the use of thermally activated flotation waste as a mineral additive does not adversely affect cement quality.

The conducted research demonstrated the feasibility of utilizing technogenic flotation waste of copper–molybdenum ores as a mineral additive in Portland cement production. Thermal activation at 800 °C significantly enhances the pozzolanic activity of the waste material. The produced cements meet all the requirements of GOST 31108–2022 in terms of technological and mechanical properties. The proposed approach contributes to the development of waste-free technologies in the mining industry, reduces environmental impact, and promotes rational use of natural resources.

### References

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