Khrystych O.V.,
Korogodska A.N.,
Shabanova G.N.,
Mykhailova E.A.

Optimization of spinel-containing alumina cements based on the CaO–Al_2O_3–CoO–NiO system composition / O.V. Khrystych, A.N. Korogodska, G.N. Shabanova, E.A. Mykhailova // Voprosy khimii i khimicheskoi tekhnologii. – 2025. – No. 4. – P. 13-22.

This paper presents the optimization of alumina cement formulations and an experimental investigation of the physical, mechanical, and technical properties of high performance, heat resistant cements derived from the CaO–Al_2O_3–CoO–NiO system. Compositions were optimized using a simplex lattice experimental design and visualized with composition–property simplex diagrams. The studies were carried out based on the tetrahedron compounds $CoAl_2O_4$–$NiAl_2O_4$–$CaAl_4O_7$–$CaAl_2O_4$ to simultaneously enhance the heat resistance and strength of the developed combinations. All three-component cross-sections in the defined tetrahedron of the CaO–Al_2O_3–CoO–NiO system were evaluated and optimal formulations were identified within the following ranges (wt.%): $CoAl_2O_4$ 5–30; $NiAl_2O_4$ 5–30; $CaAl_4O_7$ 20–40; and $CaAl_2O_4$ 20–50. Physicomechanical testing determined the most promising composition to be (wt.%): $CaAl_2O_4$ 50; $CoAl_2O_4$ 20; and $NiAl_2O_4$ 30. This cement exhibits a high strength at the age of 28 days of curing (62 MPa) and fire resistance up to 1720^0C. The refractory spinel containing alumina cement was synthesized using industrial chemical wastes as raw materials. The results demonstrate that these resource saving refractory cements meet all relevant standards and offer competitive performance. Employing recycled raw materials enables the development of novel refractory binders and contributes to improved environmental conditions in Ukraine’s industrial regions.

Keywords: optimization, multicomponent system, experimental design, synthesis; resource- efficient technology, refractoriness, strength.