THEORETICAL ASPECTS OF OBTAINING RADIATION-RESISTANT CEMENTS BASED ON ALUMINATES, FERRITES AND BARIUM ZIRCONATES

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The aim of our study is to theoretically verify whether aluminates, ferrites and barium zirconates can be used as a basis for the creation of cementitious materials with enhanced radiation resistance, to study their phase composition, physicochemical properties and resistance to ionizing radiation, taking into account the operating conditions of the nuclear industry, using modern digital technologies and artificial intelligence methods.

In the current operating conditions of nuclear facilities, in particular radioactive waste repositories and nuclear power plants, it is particularly important to use construction materials that can retain their properties under high ionising radiation. In recent years, cement compositions containing radiation-resistant phases such as aluminates, ferrites and barium zirconates have attracted the attention of scientists.

The calcium and barium aluminates ($CaAl_2O_4$, $BaAl_2O_4$) are characterised by high melting point, heat and radiation resistance, low hygroscopicity and good bonding properties.

Ferrites, in particular barium ferrite ($BaFe_{12}O_{19}$), are important components of special cements, which not only have structural stability but also the ability to absorb electromagnetic radiation.

Barium zirconates ($BaZrO_3$) are thermally stable materials with a perovskite structure and virtually non-degradable by radiation, making them promising for cement matrices.

The innovative direction of this study is the application of artificial intelligence (AI) methods, in particular machine learning, deep data analysis and neural network models, to predict the properties of cement systems. Using large amounts of experimental and theoretical data, AI algorithms allow us to

- model the optimal phase composition of cement depending on operating conditions;
- predict the degradation of the structure under different types of irradiation;
- identify microstructural changes affecting long-term stability;
- accelerate formulation selection without time-consuming and costly experiments.

Thus, the synergistic combination of classical materials science approaches and artificial intelligence tools can significantly improve the efficiency of developing radiation-resistant cements. In particular, the use of digital simulations that take into account microstructure parameters, phase thermodynamics and lifetime effects of ionizing radiation is promising.