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RADIATION PROTECTIVE PROPERTIES OF FINE-GRAINED CONCRETES AND THEIR RADIATION RESISTANCE

Many years of world experience in the selection of materials for radiation protection shows that concrete is the main material. It can combine heavy components to protect against gamma radiation and light components to absorb neutron fluxes. This fact, as well as manufacturability, low price and the possibility of using local materials, have determined the widespread use of concrete for protection against radioactive radiation.

Studies have shown that the thickness of the half layer of attenuation of the gamma radiation flux with E = 662 KeV is 3.5-5.2 cm, depending on the average density of concrete, and for a neutron flux with E = 2.5 MeV it is 5-6 cm. The radiation resistance of concrete under the influence of large doses of gamma radiation, their activity, radionuclide composition after irradiation with neutrons was investigated. To study the behavior of concrete under the influence of gamma radiation, two series of samples were made. One series was the control, and the second was exposed to gamma radiation. The temperature of the samples during testing did not exceed 40 ° C, the dose of gamma radiation was 109 rad. Its value corresponds to the dose that concrete can receive when it comes into contact with highly radioactive wastes from the Shelter facility for 300 years. The characteristic of an industrial gamma-ray plant is radiation energy of 1.25 MeV and a dose rate of 2 Mrad / h. Using this setup allows you to reach a dose of 109 rad in less than a month, and 108 rad in 4-5 days. Concrete that reached the age of 28 days and stored under normal conditions was exposed to gamma radiation. Analyzing the obtained data of physical and mechanical tests of radiation-protective compositions, it can be noted that large doses of gamma radiation practically do not affect the strength of the developed material.

The developed composites have half-value for the γ-radiation of the 137Cs isotope with energy E = 662 KeV – 3,20…5,29 cm, and for neutron radiation 252Cf with energy E = 2,5 MeV – 5,01…6, 17 cm.

The developed concrete compositions have a small activity (3-4 orders of magnitude lower) compared to natural chromium and iron if the latter are exposed to neutron radiation. The influence on the material of such a significant energy impact removes it from thermodynamic equilibrium, which creates the conditions for the occurrence of significant fluctuation processes in it, aimed at creating violations of the regularity of the structure. To reduce the intensity of fluctuations, it is advisable to create composites with a minimum value of the anisotropy of their properties, which in the developed materials is controlled by the dispersion of the aggregate and the degree of expansion of cement. This confirms the promise of using the proposed fine-grained concrete as radiation-protective materials.

It was established that the studied composites have significant radiation resistance in the fields of gamma radiation at a dose of up to 1000 Mrad. They are characterized by an increase in compressive strength and stable values of tensile strength in bending. Based on the data obtained, it is possible to develop concrete compositions for industrial production and use. It is also of interest to study the properties of these composites at the meso- and microlevels after prolonged irradiation with neutrons and gamma rays, and in the future, use of the theoretical method for modeling the transfer of neutron flux in various media. Simulation of the passage of neutrons through concrete layers of various thicknesses, in particular, a neutron flux with an energy of up to 14 MeV, will allow one to calculate the protective properties of the studied composites for plasma focus units, thermonuclear reactors, and fast neutron reactors, since experimental studies with sources of such high power is associated with a number of technical problems

Список авторів