Application of sorption method for treatment of contaminated water from ^{238}U on the example of STS water bodies

Tleukanova Zhanna, Yermakova Rinata, Aidarkhanova Almira, Mamyrbayeva Ainur

Branch "Institute of Radiation Safety and Ecology" NNC RK, Kazakhstan, 071100 Kurchatov city, 2 Beibyt Atom Str.

e-mail: Zhapasheva_zh@nnc.kz

A characteristic feature of the radioactive contamination of the environment on the territory of the Semipalatinsk Test Site (STS) is the significant levels of contamination of surface waters, including ^{238}U. Uranium in water is not only a radioactive substance, but also a chemical heat-resistant element. Water is a dynamic environment, into which radioactive substances can accumulate, be redistributed in various components of the ecosystem and migrate over long distances, polluting vast territories. World practice has shown the high importance of research aimed at cleaning water from radionuclides.

There are a number of methods for purifying water from radionuclide contamination, the most effective of which is sorption purification. To remove radionuclides from aquatic environments, various sorption materials are used, which can be divided into organic, inorganic and biosorbents. To purify the studied waters from ^{238}U, an inorganic sorbent made of synthetic aluminosilicate – zeolite NaX, polymer hydrogels and sorbents based on biomass origin (biosorbents) were selected.

The watercourses of the portal sections of the adits of the "Degelen" site and a reservoir of man-made origin located on the territory of the "Telkem" test site were selected as objects of study for the sorption purification of radioactively contaminated waters from ^{238}U. Natural waters taken from the watercourses of adits 104 and 165 and the Telkem-1 funnel were used for purification.

Experiments on water purification from ^{238}U were carried out under static conditions. To conduct the experiment, 0.4 g of the sorbent was weighed on an analytical scale with an accuracy of up to 4 decimal places, placed in a conical flask, filled with 1 liter of the collected water, tightly closed with a lid to prevent evaporation processes and constantly stirred at room temperature for 24 hours. After mixing, the analyzed solutions were filtered through a blue ribbon filter and the content of radionuclides in the filtrate was determined. The concentration of ^{238}U was determined using an ICP MASS Spectrometer "ELAN 9000" inductively coupled plasma mass spectrometer. To assess the efficiency of water purification, calculations of the sorption percentage and sorption capacity were carried out.

According to the obtained results on sorption purification of waters, it was established that the efficiency of ^{238}U sorption is determined by a number of factors, among which the key role is played by the chemical composition of the water and the composition of the sorbent. When extracting ^{238}U, the most effective biosorbents were those modified with KOH and ferrocyanides, with a sorption percentage of up to 50%. The highest values of sorption capacity were achieved in water sample 104 (up to 1100 Bq/g for ^{238}U). In the water of the Telkem-1 funnel, all sorbents demonstrated reduced sorption efficiency, which is due to high mineralization, hardness and the content of competitive ions, which prevent the binding of ^{238}U with sorbents.

As a result of the work carried out, it was established that the efficiency of sorption purification of contaminated water from ^{238}U is determined not only by the nature of the sorbent, but also by the chemical composition of the aquatic environment. Applied to ^{238}U, modified carbon biosorbents have shown the greatest efficiency, demonstrating a developed surface and active functional group that promote complex formation and sorption of uranyl ions. Thus, the work carried out makes a significant contribution to understanding the applicability of the sorption method to the purification of waters exposed to long-term man-made radiation from ^{238}U.