INFLUENCE OF MODIFICATION OF LIGNIN WITH NANO-DISPERSE Fe_3O_4 ON SORPTION OF ^{137}Cs RADIONUCLIDE FROM AQUEOUS SOLUTIONS

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One of the most important tasks of radiochemistry is the sorption extraction of radioactive isotopes of cesium from natural and technological waters.

Sorbents obtained from the waste of the woodworking industry — lignins, are prospective for the treatment of water contaminated with radionuclides, as they are widely available and have low cost. However, such sorbents, as a rule, have low kinetic characteristics and have relatively low sorption capacity.

Therefore, in order to reduce the sorption time and increase the sorption capacity, an important field is the search for ways to modify lignin. At the same time, much attention is paid to obtaining particles with a high specific surface area, which allows to increase the sorption capacity of the material. One of these methods is the impregnation of lignin with nanodispersed particles of magnetite γ-Fe_3O_4.

Modification of hydrolyzed lignin was carried out with salts of iron in an alkaline medium. Samples of the modified sorbent with a mass fraction of γ-Fe_3O_4 from 1 to 50% were obtained. For comparison, γ-Fe_3O_4 was also synthesized in the form of a finely dispersed powder.

The sorption capacity of hydrolyzed lignin, magnetite, and synthesized modified sorbents for radionuclide ^{137}Cs was studied by the limited volume method in the range of pH values from 2 to 9 under thermostatic conditions at 293 K. The solution of radionuclide ^{137}Cs ($2.4 \cdot 10^7$ Bq/dm^3) was used without a carrier.

In order to determine the time required to establish thermodynamic equilibrium, aliquots of the solution above the sorbent were taken at certain time intervals and their radioactivity was measured. The radioactivity of the model solutions before and after establishing thermodynamic equilibrium was determined according to the standard method based on the activity of the dry residue of a 0.2 cm^3 aliquot of the solution. Constancy of radioactivity of two consecutively selected samples indicated the establishment of thermodynamic sorption equilibrium in the system. The time, corresponding to the equilibrium activity of the solution was determined graphically from the dependence of the activity of the solution on the contact time of the solution with the sorbent. Radiometric measurements of the dry residue of the sample were carried out on a γ-machine NRR-610 «Tesla». The statistical error of measurements did not exceed 5%.

The sorption coefficient (K_s, %) was used as a quantitative characteristic of the extraction efficiency of the ^{137}Cs radionuclide.

The time to establish the equilibrium of the sorption of cesium ions by hydrolyzed lignin is about 3 hours, on γ-Fe_3O_4 samples it is 1 hour. Analysis of the obtained kinetic curves of ^{137}Cs sorption on modified lignin at pH=7 showed that sorption equilibrium in a heterogeneous radionuclide-sorbent system for ^{137}Cs occurs after 1.5 hours, regardless of the content of the modifier. The sorption coefficient (K_s, %) at pH=7 is 13.7% for lignin, 22.7% for γ-Fe_3O_4, and about 50% for modified lignin samples. It was found that the sorption coefficient practically does not depend on the content of the modifier.

One of the main factors affecting the sorption capacity is the pH of the solution. It was established that the dependence of sorption on pH is S-shaped and increases from 5-10% at pH=2 to 65-70% in the pH=9 region.

Comparing the obtained data, it can be concluded that as a result of the modification, there is an improvement in the kinetic and equilibrium characteristics of the new sorbent. It was found that the amount of added magnetite more than 1% practically does not affect the sorption properties of the new sorbents at different pH. The proposed sorption material is characterized by availability and simplicity of synthesis, it is not toxic. Thanks to the use of γ-Fe_3O_4 particles, it can be extracted from aqueous solutions using a magnet.