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Liquid Radioactive Wastes Treatment With Further Immobilization of Radionuclides into Mineral-Similar Sorbents

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Sorption method of liquid radioactive wastes (LRW) treatment with further immobilization of radionuclides into mineral-similar sorbents is suggested in this work. Described method can be used for decontamination of LRW from long-lived radionuclides 137Cs and 90Sr; it differs from other methods in higher efficiency of separation of radionuclides as well as in combination of stages of radionuclides concentration and immobilization with the aim of their long-term storage or final disposal. The mixed nickel-potassium ferrocyanide based on hydrated titanium dioxide was used as a sorbent. The method of production of this sorbent is developed by Radiochemistry and Applied Ecology chair of Ural federal university. Spent sorbent meets the demands for matrix materials, therefore, it can be disposed/storaged immediately in hermetically sealed container without additional immobilization into cement matrix, that will allow to reduce volume of RW and decrease storage expense.

The possibility of decontamination of wide spectrum of LRW from caesium and strontium radionuclides was experimentally confirmed.The sorbent efficiently extracts radionuclides from neutral aqueous media: the value of distribution coefficient of Cs from tap water is 10(5,6±1,0) mL/g, static exchange capasity of Cs is 270 mg/g; distribution coefficient of Sr is 10(2,9±0,2) mL/g, capasity is not less than 34 mg/g. The sorbent can be efficiently used for extraction of caesium radionuclides from high level acidic (up to 7 M HNO3), saltiness (up to 10 g/L NaNO3) and alkalescent (up to 0,002 M NaOH) solutions. With solution acidity increasing, distribution coefficient of caesium decreases to 3.7•103 mL/g at 3 mol/L of HNO3 and remains almost constant at more acidic solutions. Increasing of NaNO3 concentration up to 10 g/L also leads to decreasing of distribution coefficient of caesium; at NaNO3 concentration up to 300 g/L Kd value remains almost constant on the order of 102,75 mL/g. It is not recommended to use the sorbent alkalescent solutions with NaOH concentration more than 0.01 mol/L in view of partitional destruction of the sorbent.

It was shown that the sorbent can be efficiently used for decontamination of Cs-contaminated waters containing surfactants and EDTA. There is no any influence of surfactants on sorption of caesium at concentrations up to 10 g/L. The affect of EDTA on caesium sorption is determined. It is shown, that at initial concentrations of caesium up to 1 mg/L there is no influence of EDTA concentration (up to 0.01 mol/L of EDTA) on sorption of caesium. Distribution coefficient of caesium at 10-3 mg/L of Cs is slightly lower than at 1 mg/L of Cs; the Kd values are respectively 10(4.1±0.2) и 10(4.7±0.2) mL/g. Distribution coefficient of caesium decreases at EDTA concentrations higher than 0.01 mol/L. When initial concentration of caesium is 10-3 mg/L, distribution coefficient of caesium doesn't depend on EDTA concentration at whole studied concentration range and its value is 102 mL/g.

Leaching rates of caesium and strontium from saturated samples of the sorbent were determined. When distilled water was used as a leachant, leaching rates were 3.7·10-10 to 8.2·10-12 g/(cm2·day) for caesium and от 1,8·10-10 to 1,2·10-12 g/(cm2·day) for strontium; for tap water as a leachant leaching rates were 1,4·10-11 to1,5·10-12 g/(cm2·day) for strontium. Thus, it was experimentally confirmed that the sorbent can be successfully used as a matrix material for immobilization of radionuclides.

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