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Sorption of 137Cs from aqueous solutions onto layered double hydroxides containing the Fe(CN)64– ion in the interlayer space

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Early we studied the sorption of microamounts of 60Co2+, 85,90Sr2+, 90Y3+, 131I–, 131IO3–, 137Cs+, and 233,238U(IV) onto layered double hydroxides (LDHs) of Mg, Cu, Al, and Nd, containing various anions in the interlayer space, and also onto layered double oxide (LDO) of Mg and Al, prepared by thermal decomposition of the corresponding LDH. It was found that LDH-Mg-Al-Anion (Anion = CO32–, NO3–) solid phases did not take up 131I in the form of 131I–and 131IO3–from aqueous solutions, whereas the efficiency of the 131I–and 131IO3–removal from aqueous solution with LDO-Mg-Al exceeded 99%. Synthetic analogs of hydrotalcite of the composition LDH-Mg-Al-Nd-CO3 and LDH-Mg-Nd-CO3 allowed 90Sr2+ and 90Y3+ to be removed from aqueous solutions with more than 99% efficiency. The compounds LDH-Mg-M3+-CO3 (M3+ = Al, Nd) remove 233,238U(VI) from aqueous solutions of complex chemical composition with more than 99% efficiency. 60Co is efficiently sorbed from 10–3–10–5 mol/l aqueous Co(NO3)2 solutions onto LDH-Mg-Al and LDH-Mg-Nd with CO32–ions in the interlayer space. At the contact time of the solid and liquid phases (τ) of 15 min and V/m = 50 ml/g, Kd exceeds 2·104 ml/g for LDH-Mg-Nd and does not exceed 5·103 ml/g for LDH-Mg-Al. On the other hand, 137Cs+ was not noticeably taken up from aqueous solutions by any of the previously studied LDHs and LDOs. The highest values of Kd, equal to ~25 ml/g, were obtained for LDH-Mg-Nd-CO3 at τ = 2 h and V/m = 50 ml/g. In the other cases, Kd did not exceed ~5 ml/g.

Inorganic sorbents containing ferrocyanide ions are widely used for removing cesium radionuclides from aqueous solutions. Therefore, we prepared in this study samples of LDH-M2+-M3+-Fe(CN)6 (M2+ = Mg, Cu, Ni, Zn; M3+ = Al, Fe) and determined their physicochemical properties, including the performance in the 137Cs+ sorption.

Sorption of 137Cs from aqueous solution onto LDHs of the composition LDH-M2+-M3+-Fe(CN)6 (M2+ = Mg, Cu, Ni, Zn; M3+ = Al, Fe) was studied. The LDH-Mg-M3+-Fe(CN)6 (M3+ = Al, Fe) take up 137Cs from 10–5 mol/l aqueous CsNO3 solutions extremely weakly, whereas the LDH-M2+-M3+-Fe(CN)6 (M2+ = Cu, Ni, Zn; M3+ = Al, Fe) solid phases efficiently take up 137Cs. After 15-min contact of the solid and liquid phases, the apparent distribution coefficient Kd* of 137Cs ranges from ~3·102 to ~104 ml/g for M2+ = Cu, from ~4·103 to ~2·104 ml/g for M2+ = Ni, and from ~5·103 to ~3·104 ml/g for M2+ = Zn at V/m = 50 ml/g. As the NaOH concentration in the solution is increased, the sorption performance of the examined LDHs, except LDH-Ni-Al-Fe(CN)6, drastically decreases, which is due to the formation of LDH-M2+-M3+-OH (M2+ = Ni, Zn; M3+ = Al, Fe) having low ability to take up 137Cs.

Thus, synthetic analogs of hydrotalcite of the composition LDH-M2+-M3+-Fe(CN)6 (M2+ = Cu, Ni, Zn; M3+ = Al, Fe) allow 137Cs+ removal from aqueous solutions with more than 99% efficiency. Apparently, these compounds can find use for removing cesium radionuclides from neutral aqueous solutions in various flowsheets.

Primary author: Prof. KULYUKHIN, Sergey (Frumkin Institute of Physical Chemistry and Electrochemistry RAS)

Co-authors: Ms KRASAVINA, Elena (Frumkin Institute of Physical Chemistry and Electrochemistry RAS); Mr RUMER, Igor (Frumkin Institute of Physical Chemistry and Electrochemistry RAS)

Presenter: Prof. KULYUKHIN, Sergey (Frumkin Institute of Physical Chemistry and Electrochemistry RAS)

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