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Decontamination of anthropogenic polluted soils from Ra-226 decay family radionuclides and mercury using hydroclassification technique

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Vast territories with soils contaminated by radionuclides (RN) and/or mercury have appeared as a result of anthropogenic accidents, long-term activity of mining and processing plants, heat power plants, nuclear fuel cycle industry, as well as a consequence of decommissioning of such objects. These contaminants easily get involved to migration processes in the environment and frequently cause sustainable negative effects on ecosystems.
Modern technologies of decontamination of soils polluted by RN and/or heavy metals are based on the techniques, which either require chemicals in the processing or involve merely physical steps, as well as their combination. But the problem is that the high effective and relative cheap purifying technology has not created yet.
In this report the results of systematic researches devoted to decontamination of soils polluted by RN and/or mercury using hydroclassification technique involving pulse column equipment are discussed. This technique provides fractionating of contaminated soils and concentrating of RN in a fine fraction. As a rule, the resulting mass content of this fraction does not exceed 20% from initial mass.
The objects of the study were soils contaminated by radionuclides (RNS) or mercury (MCS). The soils have been sampled in one of the industrial plants in Russia. The samples under the study contain a significant part of construction waste along with natural soil components.
Specific activity (Q) of the initial RNS due to Ra-226 approached to the value of 12 Bq/g. Mass content of the fraction -0.01 mm ~35%. It has been determined that Ra-226 generally occurred in a form firmly coupled with organic matter and clay (~90% of total Ra-226). Mercury content in the initial MCS was extremely high and approached to the value of 350 mg/kg. Mass content of the fraction -0.01 mm ~30%. In the initial MCS, besides mercury metal, the other chemical forms like organic and inorganic mercury compounds have been detected.
Decontamination of the soils has been carried out using enlarged laboratory setup. The main apparatus of the setup was pulse hydroclassification column equipped with KRIMZ filling that ensured productivity of up to 500 kg/h. The column has been already successfully tested on soils contaminated by Cs-137. As a result of the hydroclassification of soils, up to 90% of total Cs-137 was concentrated into clay (≤15% of total mass of soils).
Hydroclassification of RNS in the optimized operation conditions provides concentrating of up to 66% of the total Ra-226 in clay fraction and returning of up to 85% mass of the initial soils for recovery Q ≤ 4 Bq/g.
As a result of hydroclassification of MCS ~63% of total mass content of the metal was concentrated in clay fraction (28% mass). Considering that mercury content of the most part of decontaminated soils had not exceeded 15 mg/kg, such soils can be used for filling pits with overlapping of a layer of clean soil with a height of at least 0.5 m.
The results obtained allowed a development of the flow sheet and the process flow diagram of stationary and mobile setups including pulse column apparatus for decontamination of soils from Ra-226 decay family RN and/or mercury.

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