Abstract

[Project Information]

Project Title :	Research and Development of Technical Systems to Realize Final Disposal Outside of Fukushima Prefecture
Project Number :	JPMEERF22S20910
Project Period (FY) :	2022-2024

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Keywords :	Removed soil and decontamination waste, volume reduction, solidification/stabilization, final disposal outside of Fukushima, scenario evaluation

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Various technologies for volume reduction and stabilization have been developed for the final disposal of radioactive cesium (Cs)-contaminated melting fly ash (MFA) and removed soil, which were generated during the remediation activities after the Fukushima Daiichi nuclear power plant accident. This study focuses on the scenario analysis that optimizes the combination of such technologies and on some basic investigations required for the analysis, i.e., evaluation of the performance of Cs concentration from ash-washing effluents of MFA, Cs sorption/desorption in natural barriers (soils), and hydrogen gas generation from stabilized wastes.

The process of final disposal of contaminated materials consists of volume reduction, stabilization and disposal. Related technologies of each process have been summarized in three representative scenarios, and these are analyzed from the point of view of mass balance, economic assessment, and CO2 emissions in addition to safety assessment. According to the Japanese regulation applied to this remediation activity, which is based on general waste management regulations but not on radioactive waste management, we propose the control of Cs-137 concentration in the landfill leachate for the safety assessment, but not the evaluation of human radiation exposure.

MFA containing Cs in water-soluble form has been generated by sending all combustible contaminated wastes to incinerators and melting furnaces. The volume of this MFA can be reduced by washing and adsorption. Based on the ion exchange theory, we proposed a performance evaluation method for adsorbents used in column adsorption. The process of column adsorption is

a relatively slow process for high concentration. A faster and effective process based on chemical co-precipitation was developed for the maximum concentration up to 2 mol/kg adsorbent and 1 GBq/kg.

Under accidental scenarios, Cs migration in soil becomes critical. A sorption/desorption model was developed based on kinetic considerations: Equilibrium theory was applied for slow leak migration and non-equilibrium theory for rapid transport. This allows for a more accurate assessment of the safety of the natural barrier, and allows for a better understanding of how the natural barrier works.

In the maximum concentration scenario, the radioactivity level reaches almost 1 GBq/kg. Therefore, the high risk of hydrogen gas generation by radiolysis of water and stabilizer at high temperatures must be evaluated. As stabilizers, blast-furnace slag mixtures of cement and geopolymer and mixtures with MFA have been investigated. Surprisingly, hydrated cement showed more than 10 times higher hydrogen gas yield than water. In order to avoid hydrogen explosion, the disposal facility for such a high-radiation stabilized form requires ventilation systems.

[References]

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This study was supported by the Environment Research and Technology Development Fund of the ERCA (JPMEERF22S20910) funded by the Ministry of the Environment.