MATERIAL CYCLES and WASTE MANAGEMENT RESEARCH

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Abstracts

【Special Issues: Special Issues: Volume Reduction, Stabilization Technology of Decontamination Waste and Prospective Structure of Its Final Disposal Site】

1. Future Initiatives of Technical Development concerning Volume Reduction and Recycling of Removed Soil Transported to the Interim Storage Facility

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Abstract
As a result of the accident at TEPCO's Fukushima Daiichi Nuclear Power Station (NPS) 11 years ago, large amounts of radioactive substances have been released into the environment, causing a case of concerning environmental pollution. The Ministry of the Environment (MOE) has taken initiatives; making efforts to conduct decontamination and disposal of the contaminated waste in order to transport the removed soil and contaminated waste (exceeding 100000Bq/kg) to an Interim Storage Facility (ISF). Under the law, final disposal of the removed soil and other materials outside Fukushima Prefecture must be completed within a span of 30 years from the start of transportation to the ISF. In order to complete final disposal of removed soil and other materials to areas outside of Fukushima within this designated time frame, the final disposal volume must be drastically reduced and the MOE is therefore implementing development of a volume-reduction technology as well as a demonstration project for recycling. The results of the demonstration project are being discussed publicly. The MOE has begun presenting feasible options for sufficient areas and structures for final disposal sites, along with developing core technologies with FY2024 being the strategic target date. Research, examination, and arrangement of the final disposal site will start after FY2025. It is absolutely necessary that final disposal of the removed soil and waste that is being transported to the ISF outside Fukushima Prefecture is actualized.

Keywords: Interim Storage Facility (ISF), final disposal outside Fukushima Prefecture, recycling of removed soil, volume reduction technology of removed soil, strategic

target (FY 2024)

2. Volume-reduction Technologies for Radioactively Contaminated Soil and Wastes and Future Tasks

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Abstract

Among the removed soil and waste contaminated by radio-cesium after the accident at Japan's Fukushima Daiichi Nuclear Power Station is now being transported into Interim Storage Facilities, those which are difficult to be recycled due to high radioactive density etc. have to be disposed outside Fukushima prefecture. Various studies on volume reduction technologies for its final disposal are being conducted and high temperature melting treatments are being adopted; actual facilities are also operating to handle radioactively contaminated incineration residue. This report explains volume-reduction technologies for fly ash that have been generated from the melting treatment and how mass balance calculation methods are being integrated. As a result of the mass balance calculation for some cases of the volume-reduction process, each of which is composed of different treatment technologies, the volume of stabilized waste has been reduced to around 1/1000 to 1/10000 of the incineration residue while its radioactivity measured in at around ten million to a handred million Bq/kg, in the process with fly ash washing. On the other hand, molten slag, washing residues, waste water, etc. are being generated and also need to be taken into consideration and managed. Hereinafter, these technologies must be verified through demonstration tests conducted by the State. The calculation methods and results for volume-reduction processes are expected to be used in the decision making of the State technical strategy.

Keywords: radio-cesium, fly ash, melting treatment, volume reduction, mass balance

3. Cement Solidification Technology for Waste

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Abstract

Cement solidification technology has been widely applied to waste stabilization and treatment because cement is not only relatively stable in physical and chemical properties after hardening, but is also an inexpensive and easy-to-handle solidification material. Treatment facilities are also simple and economical. With regard to the current status of cement solidification treatment technologies for wastes, this paper describes a study on cement solidification of wastes from the Fukushima Daiichi Nuclear Power Plant accident, the current status of cement solidification treatment for low-level radioactive wastes, and cement solidification technology for incinerated ash. It also reviews previous research results on immobilization and leaching mechanisms for heavy metals in cement solidified products.

Keywords: waste, incinerated ash, cement, stabilization, solidification

4. Applicability of Geopolymers as a Solidification Matrix for Wastes Containing Radioactive Cesium

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Abstract

Wastes containing radioactive cesium are being generated both off-site and on-site at the Fukushima Daiichi Nuclear Power Station. One of the major issues is how to treat and stabilize these wastes for safe storage, transportation, and disposal. Recently, geopolymers, which are inorganic materials like cement, has attracted attention as a new solidification material. This paper briefly reviews geopolymers and their applicability as a solidification matrix for radioactive wastes containing cesium, and presents examples of research on the solidification of such wastes conducted by our group.

Keywords: solidification, geopolymer, disposal, cesium, radioactive wastes

5. Ion-chromatographic Elimination of Radiocesium from Contaminated Fly Ash Rinse Water and Stabilization of the Spent Cesium Adsorbent

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Abstract

This article discusses an ion-chromatographic process that reduces the final amount of radioactive materials being disposed of by one-thousandth of the initial 137Cs-contaminated waste that had been stored in interim storage facilities since the Fukushima Daiichi Nuclear Power Plant accident. The process is composed of four successive processes: 1) transferring Cs from the original waste to fly ash by pyroprocessing decontamination; 2) transferring Cs from the fly ash to water by washing; 3) transferring Cs from the water to a Cs adsorbent by ion-chromatography; and 4) converting the spent adsorbent to its final radioactive disposal state by solidification/stabilization of the adsorbent. Since the ion-chromatographic process plays a major role in the volume-reduction process, based on the physicochemical analysis of the ion exchange process between Cs^{+} ions and Cs adsorbents, the mechanism of the selective Cs adsorption of transition metal ferrocyanide is chosen as a Cs adsorbent. The method for calculating the maximum amount of Cs adsorption from the ionic composition of the water used for washing the ash, and the method for designing the ion chromatography are presented as well. Other methods for converting spent Cs adsorbent to its final radioactive disposal state through cement solidification, geopolymer solidification, and phosphate glass are also given.

Key words: ^{137}Cs-contaminated waste, volume reduction, ion exchange, transition metal ferrocyanide, solidification/stabilization

6. Technical Challenges for Design of Final Disposal of Residues from Treatment of Radioactively Contaminated Soils and Wastes Caused by the Fukushima Daiichi Nuclear Power Station Accident

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Abstract

Large amounts of radioactively contaminated soil and wastes were generated from remediation works after the Fukushima Daiichi Nuclear Power Plant accident. Strategies and systemized technologies for the appropriate management of contaminated soils and wastes are being developed, including volume reduction treatment, recycling, and final disposal. This article aims to present basic information that will contribute to the design of final disposal facilities for radioactively contaminated wastes and residues derived from volume reduction treatments of contaminated soil. Firstly, options for volume reduction treatments that have been proposed by the Ministry of the Environment are briefly summarized as a means of understanding volumes and radioactive Cs concentrations for residues expected in each option. Next, based on a review of disposal facility design concepts for existing hazardous wastes and low-level radioactive wastes, technical issues surrounding the design of barrier systems for the final disposal facility of such residues are discussed.

Keywords: final disposal facilities, removed soil, radioactively contaminated waste, concrete cutoff structure, soil-bentonite mixture