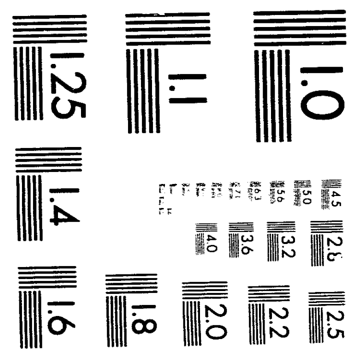
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Environmental Restoration Waste Materials Co-Disposal

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ENVIRONMENTAL RESTORATION WASTE MATERIALS CO-DISPOSAL

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ABSTRACT

Co-disposal of radioactive and hazardous waste is a highly efficient and cost-saving technology. The technology used for final treatment of soil-washing size fractionization operations is being demonstrated on simulated waste. Treated material (wasterock) is used to stabilize and isolate retired underground waste disposal structures or is used to construct landfills or equivalent surface or subsurface structures. Prototype equipment is under development as well as undergoing standardized testing protocols to prequalify treated waste materials. Polymer and hydraulic cement solidification agents are currently used for geotechnical demonstration activities.

INTRODUCTION

During the past 5 decades, copious quantities of waste materials have been produced by defense-related nuclear operations at many U.S. Department of Energy (DOE) sites. As defense nuclear operations are reduced or eliminated, additional volumes of waste materials will be produced by environmental restoration activities. Westinghouse Hanford Company, under the direction of the DOE Richland Operations Office, is developing processes for disposal of these waste materials. "Co-disposal" is a process of disposing of radioactive and/or hazardous nuclear-generated waste materials in combination and simultaneously with disposal of waste materials produced from environmental restoration retrieval actions. The co-disposal process is a significant waste-minimization and resource-avoidance technology. As such, use of this technology can result in large cost savings.

Co-disposal can be used as an interim remediation action for existing high-consequence radiological/industrial-risk underground waste structures. Alternatively, the process can be used for primary confinement, secondary confinement, and shielding of waste packages in landfills or equivalent structures. This process uses nearly 100 percent of the volume of the landfill by incorporating waste packages produced by waste generators within a solidified matrix. This solidified matrix is composed of waste materials and high durability, high strength, low hydraulic conductivity, highly immobilizing binding materials. If this solidified matrix were used, the waste package loading in the landfill or similar structure can be easily increased by 150 to 300 percent.

Co-disposal is being evaluated on engineering scale tests conducted in conjunction with soil-wash demonstration activities at the Hanford Site. Test conditions simulate actual waste site remediation where (1) waste materials are exhumed, (2) size fractionization by soil washing is performed on the exhumed material, (3) the fine-fraction slurry (i.e., the contaminated fraction) is collected, (4) the slurry is treated, and (5) the treated slurry is disposed of in an appropriate surface or subsurface location. Testing is being conducted at the Hanford Geotechnical Development and Test Facility. Treatment is conducted in accordance with past-practice *Resource Conservation and Recovery Act of 1976* (1) (RCRA) or *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) (2) regulatory guidance.

SIMULATED WASTE FEED MATERIALS

Co-disposal has the capability to use most of the bulk contaminated waste materials. Soil-wash size fractionization is being tested to evaluate physical and hydraulic separation and concentration of highly contaminated fine sediments from less contaminated, coarser fractions. These sediments originating from crib, settling basin, burial ground, drainfield, and similar waste disposal structures typically contain mixed fission products, activation products, heavy metals, and organic solvents.

Glaciofluvial sediments similar to those contaminated with process nuclear and hazardous waste originating from the 300 Area at the Hanford Site are being used for testing. They were removed from a spoils pile and introduced into the soil-wash size-fractionization system using a large trackhoe. The bulk material was dry (approximately 2 percent water by volume). The bulk material was classified as bimodially distributed coarse gravely sand. This material has been tested relative to solidification for barrier application by Brookhaven National Laboratory (3).

MOBILE UNIT OPERATIONS

Size fractionization by mechanical separation and soil washing was completed using several in-series integrated unit operations. The purpose of size fractionization was to separate coarse fraction from fine fraction, and uncontaminated materials to moderately contaminated materials, respectively. This initial demonstration of size fractionization was conducted on uncontaminated geologic media; however, the media are similar in mineralogy and gradation to contaminated geologic media currently being treated.

The primary fractionization unit operation consists of a large grizzley for separation of the very coarse fraction (boulders). The grizzley removed the greater than 1.5×10^2 mm fraction to a discharge pile. The second unit operation consists of two vibrating screens. The top screen has an attached spray bar to add water to control dust, which produced a slurry discharge of less than approximately 5.0×10^{-1} mm materials. The bottom screen was used to separate the 2.5×10^1 mm fraction and to remove the retained fraction to a discharge pile. The passing fraction then was retained in a large, lateral discharge belt conveyor housed in a hopper that was 3.0 m^3. The discharge material from the hopper was moved to washing operations via a piler/conveyor.

The geologic media passing through the 2.5×10^1 mm screen then was introduced into a trommel (third unit operation) at rates varying from 6.7×10^{-2} $m^3 \cdot s^{-1}$ to 1.3×10^{-1} $m^3 \cdot s^{-1}$ throughput. Water was added to the trommel from surge tanks at a rate of approximately 6.3×10^{-5} $m \cdot s^{-1}$.

The coarse fraction (greater than 2.0 mm) exited the trommel to a discharge pile (i.e., the fourth unit operation). The fifth step was the discharge of the remaining fraction from the trommel to a vibrating table. The sixth unit operation consisted of separating the fraction that was greater than 2.0 x 10^{-1} mm into a discharge pile, and the last unit operation of discharge separated the fraction that was less than 2.0 x 10^{-1} mm into a slurry discharge. The discharge slurry entered a series of siphon-connected cascade settling tanks for collection. After activities ceased, these media were collected from each settling tank and homogenized into a final simulated waste feed material.

A simplified flow schematic for unit operations and the overall size fractionization system is shown in Figure 1. Unit operations were obtained from the DOE and U.S. Environmental Protection Agency sources.

Place Figure 1 here.
Figure 1. Size Fractionization Operations and Fine Fraction Production.

WASTE FORM QUALIFICATION FOR DISPOSAL

Waste forms produced by co-disposal require prequalification before placement into a landfill or similar structure. Prequalification involves real-time and accelerated laboratory testing of mixtures of bulk materials and binders. Prequalification must be completed for each contaminant-material feed and waste disposal media at the most conservative waste loadings and over a range of physicochemical conditions. A suite of nominally 27 different tests are conducted following guidance given in Title 10 of the *U.S. Code of Federal Regulations* (4). Current testing involves strength and durability tests of fraction less than 2.0 to 0.2 mm and the fraction less than 0.2 mm.

Laboratory testing of size-fractionization slurry feed materials currently is being conducted with polymer and hydraulic cement binders. Laboratory tests of equivalent feed materials with admixed sequestering agents in hydraulic cement have been completed (5 and 6).

Polymer concrete is being produced with the size-fractionization slurry and washed soil fraction that is less than 2.0 mm, using methacrylate polymer. This polymer consists of dicyclopentadienyl methacrylate and isooctyl acrylate polymerized with cobalt octolate and catalyzed with cumene hydroperoxide. The polymer is introduced using a rotary mixer when the slurry or 2.0 mm granular feed material is at or near saturation (approximately 42 percent void volume). Alternatively, the aqueous polymer may be added to the granular feed by flooding and vibrating the bulk material to induce saturation. The resultant material is termed "wasterock."

Hydraulic cement is also being produced with the fine and slurry fraction of the washed soil material. Cement (portland type I, II, or H), fly and bottom ash (coal-fired steam-plant waste), simulated contaminated water, and plasticizer (i.e., sodium haphthalenesulfonate-formaldehyde) are added to the washed soil fraction using mechanical homogenizers. This material is also called wasterock because it uses contaminated materials as primary aggregate and solidification binders.

Both the polymer concrete and hydraulic cement binders are placed concurrently or subsequently with simulated contaminated soil size fractions in reusable steel forms containing reinforcing bar. The resulting material become large durable monoliths, after solidification and removal from the forms. These monoliths can be produced by the waste generator or at the point of disposal. The monoliths can be retrieved from a disposal structure after site closure if required by regulatory mandate. The large monoliths also can be configured within a waste management facility to serve as radiological shielding during their interim status before final disposal.

In contrast to production of monoliths with contaminated soil, polymer concrete or hydraulic cement can be directly pumped into working radioactive and/or hazardous waste landfill waste packages interstices before the mixtures solidify. This produces a continuous large monolithic body surrounding the waste materials, which would replace the requirement for backfilling with uncontaminated soil or equivalent granular media. Placement of the mixtures in slurry form can be performed using remote equipment. This equipment currently is being demonstrated using uncontaminated hydraulic cement for disposal of large, highly radioactive filters containing hazardous constituents.

Direct injection of slurry into physically unstable underground structures is also an alternative application for wasterock. Use of wasterock originating primarily from contaminated waste sites to stabilize and isolate other waste disposal sites is of particular health physics and economic benefit. Percussion jet-injection prototype equipment currently is being modified for use in stabilization of unstable waste materials in underground cribs, burial grounds, vaults, caissons, pipelines, foundations, etc. This equipment remotely accesses the disposal structure and injects wasterock into the accessible void volume of the structure.

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