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SITE
SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION

Technology Demonstration Summary

SITE Program Demonstration Test, Soliditech, Inc. Morganville, New Jersey

The major objective of the Soliditech, Inc., SITE demonstration was to develop reliable performance and cost information about the Soliditech solidification, stabilization technology. The Soliditech process mixes hazardous waste materials with portland cement or pozzolanic material (such as fly ash), a proprietary reagent called Urrichem, proprietary additives, and water to aid in the physical and chemical immobilization of the hazardous waste constituents. The demonstration took place at the site of a former chemical processing and oil reclamation facility in Morganville, New Jersey. Site contamination included petroleum hydrocarbons, PCBs, other organic chemicals, and heavy metals.

The technical criteria used to evaluate the effectiveness of the Soliditech process were contaminant mobility based upon extraction, leaching, and permeability tests; and structural integrity of the solidified material, based upon measurements of physical properties.

Extensive sampling and analyses indicated (1) a reduction of heavy metals in the extract or leachates of the solidified waste samples, (2) no volatile organic compounds in the TCLP extract of the solidified waste, (3) detectable levels of phenols and cresols in the TCLP extract of the solidified waste samples, (4) the process is capable of solidifying wastes containing moderate levels of oil and grease, and (5) structural stability in the solidified waste with moderate volume increase.

This Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce the key findings of this SITE demonstration. These findings are fully documented in two separate reports (see ordering information at back).

Introduction

In response to the Superfund Amendments and Reauthorization Act of 1986 (SARA), the EPA's Offices of Solid Waste and Emergency Response (OSWER) and Research and Development (ORD) have established a formal program to accelerate the development, demonstration, and use of new or innovative technologies that offer permanent, long-term cleanup solutions for hazardous wastes. This new program is called Superfund Innovative Technology Evaluation, or SITE.

The SITE program has four primary goals:

- To identify and remove impediments to the development and commercial use of alternate technologies.
- To conduct a demonstration of the more promising innovative technologies to establish reliable performance and cost information for site characterization and cleanup decision-making.
- To develop procedures and policies that encourage the selection of available alternative treatment remedies at Superfund sites as well as other waste sites and commercial facilities.
- To structure a development program that nurtures emerging technologies.

Soliditech, Inc., of Houston, Texas, developed one such technology. The Soliditech process involves mixing hazardous wastes with pozzolanic material or cement, proprietary additives, water, and a proprietary reagent called Urrichem. Soliditech claims that its process aids in the chemical and physical immobilization of the hazardous waste constituents. The solidified product is intended to have excellent unconfined compressive strength (UCS), high stability, and a rigid consistency similar to that of concrete.

The Imperial Oil Company/Champion Chemical Company Superfund site in Morganville, New Jersey, was chosen for the demonstration. Past activities at the site include chemical processing and oil reclamation. The chemicals of concern at this site include metals, such as arsenic, chromium, copper, lead, nickel, and zinc, as well as various organic chemicals including polychlorinated biphenyls (PCBs) and petroleum hydrocarbons. Contamination is present at the site at many locations in soil, a waste filter cake pile, and an abandoned storage tank, as well as in the ground water. Samples of contaminated material from the soil at Off-Site Area One, the waste filter cake pile, and the abandoned storage tank were treated during the demonstration.

This SITE demonstration was conducted to determine the following:

- The effectiveness of the technology to solidify and stabilize waste materials found at the site.
- The ability of the solidified materials to maintain physical properties and structural stability over a 5-year period.
- The change in volume and density of the solidified material after adding cement, water, reagent, and other additives.
- Reliable capital and operating costs for use in the Superfund decision-making process.

A SITE Demonstration Plan detailed all sampling and analysis to be performed during the Soliditech demonstration. Analytical tests were performed on samples of untreated as well as solidified waste material collected during the demonstration. The results were used to evaluate the effectiveness of the treatment process and the structural properties of the resulting solidified material. Soliditech personnel maintained operating logs to determine the capital and operating expenses associated with the demonstration. Both Soliditech and EPA personnel maintained field logs of the volume and weight of all ingredients for each test run, as well as the volume and weight of all treated material.

Project documentation consists of two reports. A Technology Evaluation Report describes the field activities and laboratory results. An Applications Analysis Report interprets the data, conclusions, and potential applications of the technology.

Approach

During the demonstration, three types of waste material - contaminated soil, waste filter cake material, and oily sludge - were collected and screened, when necessary, prior to treatment.

Untreated waste samples were collected for each test parameter from each of these three waste materials. These samples were analyzed for total chemical constituents, physical characteristics, and the amount of solubles removed by non-destructive leaching and destructive extraction procedures. The results allow a direct comparison of physical and chemical properties between the treated and untreated waste, and a determination of effectiveness of the treatment process.

Each waste material, as well as a control mix using clean sand, was treated by a batch-mixing process after adding the chemical reagents and additives, water, and cement. Once thoroughly mixed, the treated waste was discharged from the mixer into large 1-cubic ya plywood forms. Figure 1 depicts overview of the Soliditech processi equipment, and Figure 2 is an overvie of the Soliditech demonstration progress.

Numerous cylindrical samp containers or forms, as required f chemical and physical testing, were fill with treated waste, sampled from t large forms, and allowed to cure for days. The final product was a monolith material with measurable structur strength. After curing, the small samp cylinders were shipped to th laboratories for analysis. The plywo sides of the large 1-cubic yard forr were removed and the resulting treat waste monoliths were placed in enclosed on-site storage area for lon term monitoring. Long-term studi include a 6-month leaching te extraction procedures at various times to 5 years after treatment, a petrographic observation and analys These tests will help to assess the lon term stability of the treated material

The control run, using clean sand, w performed to ensure that the Solidite reagents and additives were n contributing to the contamination of t other samples, and to provide basel values for some of the physic properties. These samples were analyz for chemical constituents, physic characteristics, and the ability withstand leaching/extraction.

The Soliditech Demonstration Pl included a Quality Assurance Proje Plan that detailed quality assurance a quality control procedures for t demonstration sampling and analys activities. U.S. EPA performed both field audit during the demonstration and laboratory audit to ensure that all qual assurance and quality control procedur were followed. The audits found that t sampling activities and analytical d met the goals prescribed in the qual assurance plan.

Result

The analyses of the samples collect before, during, and after the Solidite demonstration are summarized in Tabl 1 and 2, and discussed below:

Untreated Waste - Untreated wa from the site consisted of contaminat soil, filter cake, and a filter cake/o sludge mixture. These wast contained 2.8 to 17 percent oil a grease, with relatively low levels other organic compounds. P

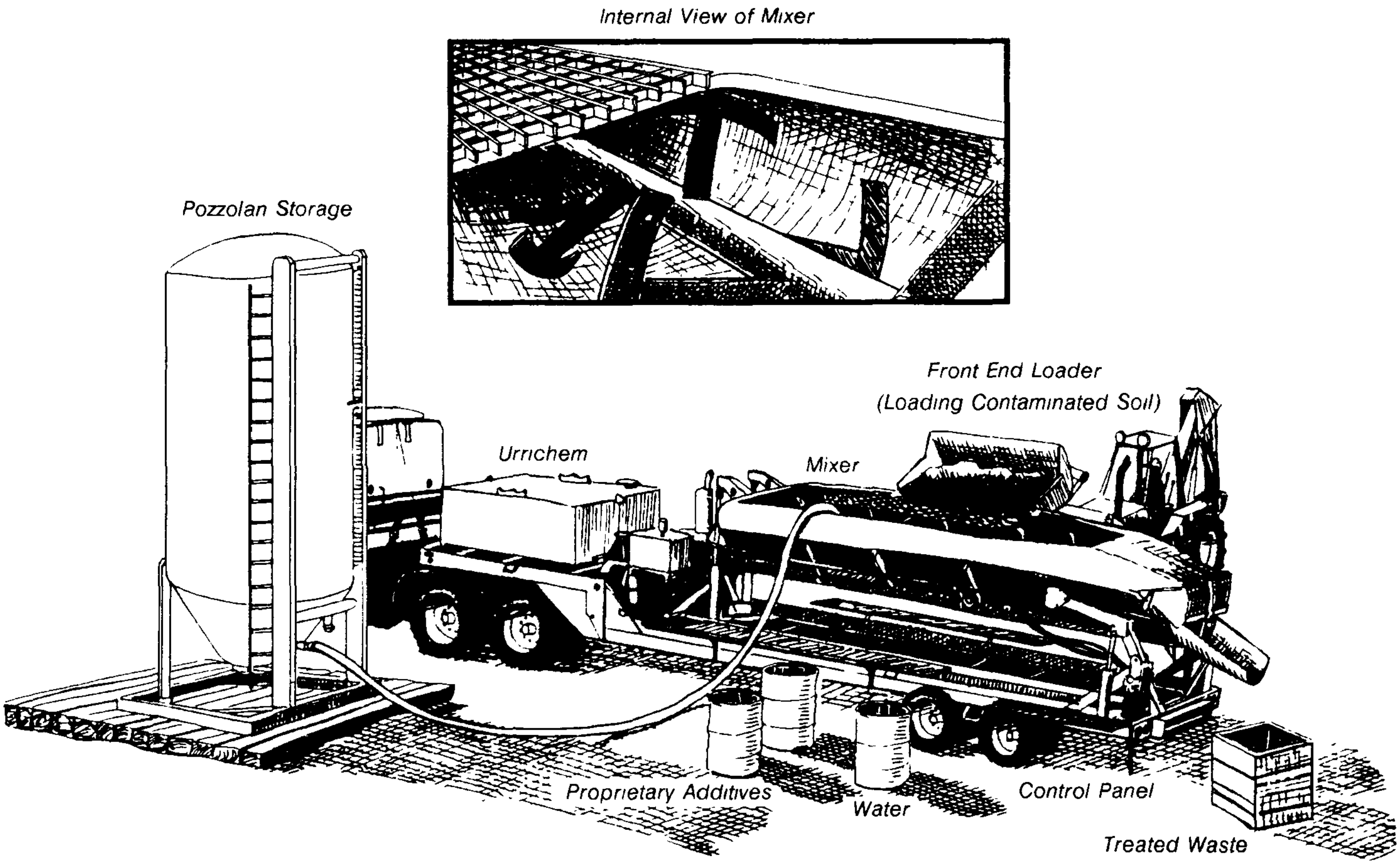

Figure 1. Overview of Soliditech processing equipment.

(Aroclors 1242 and 1260) concentrations ranged from 28 to 43 mg/Kg; arsenic concentrations from 14 to 94 mg/Kg; lead concentrations ranged from 650 to 2,500 mg/Kg; and zinc concentrations from 26 to 150 mg/Kg.

Treated Waste – The Soliditech stabilization process produced solidified waste with high structural stability and low permeability. UCS values ranged from 390 to 860 psi. Permeability values ranged from 8.9 x 10^{-9} to 4.5 x 10^{-7} cm/sec. Because of the cementitious additives in the Soliditech process, pH values of the solidified wastes ranged from 11.8 to 12.0. Arsenic concentrations ranged from 28 to 92 mg/Kg; lead concentrations from 480 to 850 mg/Kg; zinc concentrations from 23 to 95 mg/Kg; and PCB (Aroclors 1242 and 1260) concentrations from approximately 15 to 40 mg/Kg. Low concentrations of phenol and p-cresol were found in solidified filter cake and filter cake/oily waste samples. These compounds were not detected in the untreated wastes.

Control Mixture – The control mixture contained 20 mg/Kg lead. PCBs, phenols, and cresols were not detected in the control mixture. The reagents used for the solidification could not be analyzed for phenol, o-cresol, and p-cresol because of the high alkalinity in the control samples. Low levels (0.06 µg/L, total) of volatile organic compounds were detected in the TCLP extract of the control mixture.

Extract of Untreated Waste – Arsenic, lead, and zinc were found in EP, TCLP, and BET extracts of the untreated wastes. No PCBs were detected in any extracts of the untreated wastes. Total concentrations of up to 1.3 mg/L of volatile organic compounds and up to 0.38 mg/L of semivolatile organic compounds were detected in the TCLP extract of the untreated waste. Oil and grease concentrations of 1.4 to 1.9 mg/L were detected in the TCLP extract of the untreated waste. Untreated wastes could not be tested by ANS 16.1.

Extract of Treated Waste – Significantly reduced amounts of metals were detected in the TCLP, EP, BET, ANS 16.1, and WILT extracts and leachates of the treated waste. No PCBs or volatile organic compounds were detected in any extract of the treated waste. Phenol, p-cresol, o-cresol, and 2,4-dimethylphenol were detected in the post-treatment TCLP waste extracts. Oil and grease concentrations of 2.4 to 12.0 mg/L were detected in the TCLP extracts.

Summary

The SITE demonstration for the Soliditech technology was performed on three hazardous waste feedstocks as well

Figure 2. *Overview of the Soliditech demonstration in progress*

Table 1. Physical Properties

	Filter Cake		Filter Cake/Oily Sludge Mixture		Off-Site Area One	
	Untreated	Treated[a]	Untreated	Treated[a]	Untreated	Treated[a]
Bulk Density (g/cm^3)	1 14	1.43	1.19	1.68	1.26	59
Permeability (cm/sec)	NA[b]	4.53×10^{-7}	NA	8.93×10^{-9}	NA	3.41×10^{-8}
Unconfined Compressive Strength (psi)	NA	390	NA	860	NA	680
Loss on Ignition (%)	54	41	70	34	36	34
Water Content (%)	28.7	21.0	58 1	14 7	23.5	12.6

[a]Treated waste sampled after a 28-day curing period.
[b]NA = Not analyzed.

as one control run of clean sand. The test runs using hazardous waste produced approximately 3- to 7-cubic yards of solidified material from each of the three waste types. Nearly 400 mold cylindrical samples were collected fo

Table 2. Chemical Properties

Chemical Parameter[a]	Filter Cake				Filter Cake/Oily Sludge Mixture				Off-Site Area One			
	Untreated Waste	Treated Waste[b]	Leachate from Untreated Waste[c]	Leachate from Treated Waste[c]	Untreated Waste	Treated Waste[b]	Leachate from Untreated Waste[c]	Leachate from Treated Waste[c]	Untreated Waste	Treated Waste[b]	Leachate from Untreated Waste[c]	Leachate from Treated Waste[c]
pH	3.4	11.8	4.6	10.8	3.6	12.0	4.8	11.6	7.9	12.0	5.1	11.5
VOCs[d]	ND[e]	ND	0.27[f]	ND	50[f]	ND	1.3[f]	ND	10	ND	0.87[f]	ND
SVOCs[g]	ND	36[f]	ND	1.2	63[f]	17[f]	0.38	0.97[f]	79[f]	16[f]	0.12[f]	0.32[f]
PCBs[h]	28	16	ND	ND	43	15	ND	ND	43	40	ND	ND
Oil and grease	170,000	77,000	1.4	4.4	130,000	60,000	1.6	2.4	28,000	46,000	1.9	12
Arsenic	26	28	0.005	ND	14	40	0.014	ND	94	92	0.19	ND
Lead	2,200	680	4.3	0.002	2,500	850	5.4	0.014	650	480	0.55	0.012
Zinc	26	23	0.28	ND	150	54	1.3	ND	120	95	0.63	ND

[a]Analyte concentration units for the untreated and treated waste are mg/Kg. Analyte concentration units for the leachate from untreated and treated waste are mg/L.
[b]Treated wastes were sampled after a 28-day curing period.
[c]Leachate values refer to results from TCLP test.
[d]VOCs = volatile organic compounds.
[e]ND = not detected.
[f]These values contain low levels of acetone, methylene chloride, various phthalates, or other analytes which are commonly attributed to sampling or analytical contamination.
[g]SVOCs = semivolatile organic compounds.
[h]PCBs = polychlorinated biphenyls.

wide range of laboratory tests and analyses. These tests allowed comparisons of both chemical and physical properties and contaminant mobilities of the waste materials before and after treatment. The following observations were made

- Due to the treatment process, the solidified wastes increased in volume by a range of 0 to 60 percent (average of 22 percent) The bulk density of the waste material increased by approximately 30 percent due to solidification.
- The UCS of the solidified wastes ranged from 390 to 850 psi.
- Weight loss due to 12 cycles of wet/dry weathering of the solidified waste was less than one percent of the original weight.
- There was no measurable weight loss of the solidified waste after 12 cycles of freeze/thaw weathering.
- Permeabilities of treated waste ranged from 8.9×10^{-9} to 4.5×10^{-7} cm/sec.
- Water content of the untreated waste ranged from 24 to 58 percent; treated waste contained 13 to 21 percent water.
- The pH of the solidified waste ranged from 11.8 to 12.0. The pH of the untreated waste ranged from 3.4 to 7.9.
- Chemical analyses of extracts from TCLP, EP Toxicity, and BET procedures showed that heavy metals present in the untreated wastes were immobilized by treatment.
- Chemical analyses of leachates from intact cast cylinders subjected to ANS 16.1 and WILT procedures showed that heavy metals present in the untreated wastes were immobilized by treatment.
- Oil and grease content of the untreated waste ranged from 2.8 to 17 percent. Oil and grease content of the solidified waste ranged from 4.6 to 7.7 percent. Oil and grease content of the TCLP, EP Toxicity, and BET extracts of both the untreated and treated waste ranged from not detected to 26 mg/L. Oil and grease content of the ANS 16.1 leachate from intact cast cylinders ranged from not detected to 3 mg/L. Oil and grease content of WILT leachates from intact cast cylinders decreased substantially over the first 8 leaching cycles.
- Phenol, o-cresol, p-cresol, and 2,4-dimethylphenol were detected in TCLP extracts from treated waste at concentrations of up to 0.6 mg/L higher than in the TCLP extract from the untreated waste.
- A total concentration of 300 µg/L of ethylbenzene, toluene, trichlorethene, and total xylenes was detected in th TCLP extract of the untreated wast samples. No volatile organi compounds were found in the TCL extract from the treated wast samples. A total concentration c toluene and total xylenes of 0.06 µg/ was detected in the TCLP extract fror one of three replicate reagent mi samples.
- PCBs were not detected in an untreated or treated extracts o leachates.
- Microstructural studies are ongoinc however, visual observation of th broken pieces of the solidified wast show numerous dark inclusion approximately 1 mm in diametei these are judged to be the oil an grease component of the waste.
- Measurement of the exact weight an volume of wastes treated was difficul Variations of as much as plus or minu 34 percent of the quantity of untreate waste material were found.
- Based upon data obtained fron Soliditech as well as data collecte during the demonstration, a cost o approximately $150/ton was estimate for the treatment of 60,000 cubic yard of contaminated soil using th Soliditech process.