SITE DEMONSTRATION OF TERRA-KLEEN RESPONSE GROUP'S MOBILE SOLVENT EXTRACTION PROCESS

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INTRODUCTION

In 1986 the Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) and the Office of Research and Development (ORD) established the SITE Program to Promote the development and use of innovative technologies to clean up uncontrolled hazardous waste sites across the country. The SITE Program is composed of four major elements: the Demonstration Program, the Emerging Technologies Program, the Measurement and Monitoring Technologies Program and the Technology Transfer Program. The Demonstration Program is designed to provide engineering and cost data for selected technologies, by evaluating their ability to treat wastes from Superfund sites.

The Terra-Kleen Response Group (TKRG) requested that EPA's SITE Program evaluate their mobile solvent extraction technology, and was selected for evaluation under the Demonstration Program. This technology is a batch process system which uses proprietary solvents to separate organic contaminants from soils, sediments, and/or sludges. Organic contaminants are concentrated during processing, thus reducing the volume of hazardous wastes for final disposal. Therefore, this technology is non-destructive.

TKRG's solvent extraction process is transportable and can be configured to treat both small or large quantities of solids. System components are often available from local suppliers throughout the United States. This reduces setup time and can reduce the amount of down time associated with equipment replacement.

Processing begins following excavation of contaminated solids and loading them into extraction vessels. The vessels are covered and clean solvent at ambient temperature and pressure is pumped into each one. Organic contaminants in the solids leach into the solvent without the aid of a mixing device. Contaminated solvent then flows into a clarifier where heavy solids are separated by gravity from the solvent. Clarified solvent is pumped through a microfilter which removes fines, and then through a proprietary regeneration unit which concentrates the organic contaminants. Clean solvent, discharged from the regeneration unit, is stored in a holding tank for reuse. This sequence of treatment steps is repeated until contaminant concentrations of the solids within the extraction vessels are reduced to a desired level. Some residual solvent still remains with the solids. Therefore, at this point in the process all solvent carrying lines are drained and vacuum extraction is used to reduce the concentration of solvent in the solids.

Treated solids are typically removed from the vessels by a front end loader and returned to the site. Concentrated contaminants are removed and disposed of off-site in accordance with applicable regulations. Regenerated solvent may be used for treatment of solids at other waste sites.

The SITE Demonstration of this technology was conducted during May 1994 in cooperation with the Naval Environmental Leadership Program (NELP) at Navel Air Station North Island (NASNI) which is located near San Diego, California. TKRG was contracted by NASNI to treat five tons of polychlorinated biphenyl (PCB) contaminated soil. This project was considered to be a pilot-scale demonstration of the capabilities of the TKRG's solvent extraction process. The primary objective of this demonstration was to determine if the process could achieve a soil clean up level of <2.0 mg/kg total PCB.

METHODOLOGY

A backhoe was used to excavate five tons of PCB contaminated soil from NASNI Site 4. The excavated soil was then homogenized by using the front end loader of the backhoe for mixing. Five extraction vessels were tared and each were filled with approximately one ton of the homogenized soil and weighed. A sampling grid was laid out across the top of each vessel and a core sampler was used to collect seven samples from each vessel. The seven samples were composited by vessel such that a composite sample represented the contents of an individual vessel. These samples were analyzed for PCBs, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs) in accordance with Test Methods for Evaluation of Solid Wastes Physical/Chemical, 1992 (SW-846).

Following sample collection clean solvent was added to each extraction vessel and permitted to drain into a clarifier. Samples of the extraction solvent were periodically collected from the drain lines leading to the clarifier. The clarified solvent was pumped through a 5 micron bag filter and TKRG's proprietary solvent regeneration system. Samples of the regenerated solvent were collected periodically and analyzed for PCBs. Regenerated solvent was pumped into a storage tank and was held there until it was reutilized for subsequent extraction cycles.

When the solvent in all of the five extraction vessels had finished draining to the clarifier, the drain lines were closed and a second extraction cycle was initiated. The extraction cycles were continued until the measured concentration of PCBs in the drained solvent was <1.0 mg/L. At this point, the suction side of a centrifugal blower was connected to the drain lines of each extraction vessel and was operated continuously for three days. This was done to remove residual solvent from the solids. Following this treatment a mixture of nutrients and microorganisms were added to the extraction vessels to biologically degrade any remaining solvent. After two weeks of this biological treatment a sampling grid was reestablished for each extraction vessel and seven core samples of the solids were collected, composited, and analyzed as described above.

RESULTS

The characteristics of the soils obtained from each extraction vessel prior to treatment are shown in Table 1. Untreated soil was predominantly a dry sand with an average moisture content of 0.83 percent and 93.6 percent of the solids retained on a 0.075 mm screen. Polynuclear aromatic hydrocarbons (PAHs), hexachlorodibenzo furans (HxCDFs), and pentachlorodibenzo furans (PeCDFs) were identified, but only at very low concentrations. Bis(2-Ethylhexyl)phthalate was also identified at <0.7 mg/kg in the untreated soils. Other analyses showed the average Oil and Grease concentration at 759 mg/kg and the average total PCB concentration at 144 mg/kg.

TABLE 1
PHYSICAL AND CHEMICAL CHARACTERISTICS OF UNTREATED SOILS

Extraction Vessel	A	B	C	D	E	Avg.	S.D.
Particle Size (% >0.075 mm)	92.7	93.4	93.4	93.5	95.0	93.6	0.85
Moisture Content (%)	0.79	0.79	0.79	0.80	0.99	0.83	0.09
Total PAHs (mg/kg*)	2.10	2.23	3.38	1.55	1.94	2.24	0.69
Total HxCDF (ug/kg*)	0.658	0.629	0.647	0.848	0.704	0.697	0.089
Total PeCDF (ug/kg*)	<.409	0.144	<.343	0.162	0.218	<.255	-
Total PCB (mg/kg*)	130	140	134	146	170	144	15.7
Oil & Grease (mg/kg*)	753	726	713	737	868	759	62.5

* dry weight

A total of 11 extraction cycles were completed over 7 days for each of the 5 one ton batches of contaminated soil. Three days of vacuum extraction were then completed to reduce the concentration of residual solvent in the treated solids. Upon completion of vacuum extraction, a mixture of microorganisms and nutrients was added to each extraction vessel. After two weeks soil samples were collected from each vessel and analyzed for contaminants.

Low initial contaminant concentrations at or near method detection limits precludes the use of PAH, HxCDF, and PeCDF data for evaluation of the process. The results of PCB and Oil and Grease analyses and removal efficiencies for each are shown in Table 2.

Solvent concentrations in treated solids ranged from 4.7 to 3.6 percent prior to vacuum extraction. Following three days of vacuum treatment residual solvent in the solids was found to be between 2.7 and 1.8 percent. Fourteen days of biological treatment further reduced solvent concentrations to <0.5 percent.

TABLE 2
CONTAMINANT CONCENTRATIONS AND REMOVAL EFFICIENCIES OF TREATED SOILS

Extraction Vessel	A	B	C	D	E	Avg.	S.D.
Oil and Grease (mg/kg*)	327	300	252	167	318	273	65.8
Removal Efficiency (%)	56.6	58.7	64.6	77.3	63.4	64.0	8.1
Total PCB (mg/kg*)	1.79	1.63	1.79	1.88	1.96	1.81	0.12
Removal Efficiency (%)	98.6	98.8	98.7	98.7	98.8	98.7	0.1

* dry weight

CONCLUSIONS

TKRG's solvent extraction process was effective in removing PCBs and Oil and Grease from dry sandy soils. The extraction process was operated for 11 cycles to achieve a predetermined remediation goal of <2.0 mg/kg PCB in soil. Oil and Grease concentrations in the contaminated soils were also reduced to <330 mg/kg. All five batches treated met the remediation goal demonstrating that treatment of solids was consistent. Vacuum extraction combined with biological treatment was able to reduced the concentration of residual solvent in treated solids to <0.5 percent. Further reduction of residual solvent concentrations in solids may have been possible if treatment would have been allowed to continue.

FOR MORE INFORMATION:

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