United States Environmental Protection Agency

Office of Research and Development Cincinnati, OH 45268

EPA/540/R-94/507a
August 1994

EPA

SITE Technology Capsule

Clean Berkshires, Inc. Thermal Desorption System

Introduction

In 1980, the U.S. Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund. CERCLA is committed to protecting human health and the environment from the dangers posed by uncontrolled hazardous waste sites. CERCLA was subsequently amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986, emphasizing long-term effectiveness and permanent remedies at Superfund sites. SARA also encourages the use of alternative treatment or resource recovery technologies to the maximum extent possible to achieve these goals.

State and federal agencies as well as private parties are now exploring a growing number of innovative technologies for treating hazardous wastes. The sites on the National Priorities List total over 1,200 and comprise a broad spectrum of physical, chemical, and environmental conditions requiring varying types of remedial responses. The U.S. Environmental Protection Agency (EPA) is leading the effort to define policy, technical, and information issues related to developing and applying new remediation techniques at Superfund sites. One such EPA initiative is the Superfund Innovative Technology Evaluation (SITE) Program, which was established to accelerate development, demonstration, and use of innovative technologies for site cleanups. To disseminate information on the latest technologies, EPA created SITE Technology Capsules. These concise documents are designed to help EPA remedial project managers, EPA on-scene coordinators, contractors, and other site cleanup managers understand the types of data and site characteristics needed to effectively evaluate a technology's potential for cleaning up Superfund sites.

This Capsule provides information on the Clean Berkshires, Inc. (CBI), now renamed Maxymillian Technologies, Inc. Thermal Desorption System (TDS), a technology developed to remove organic compounds from soil. The CBI TDS was evaluated under EPA's SITE Program in November/December 1993 at a former manufactured gas plant (MGP) site where soils are contaminated primarily with coal coking by-products. Information in this Capsule emphasizes specific site characteristics and results from the SITE Demonstration Test. Additional results including TDS performance at a soil recycling site in western Massachusetts were provided by CBI and are summarized in the Technology Status section. This Capsule contains the following information:

- Abstract
- Technology Description
- Technology Applicability
- Technology Limitations
- Process Residuals
- Site Requirements
- Performance Data
- Technology Status
- Source of Further Information

Abstract

The thermal desorption process devised by CBI uses standard rotary kiln technology to remove organic contaminants from excavated solid wastes. The process works by vaporizing and isolating the constituents in a gas stream and then destroying them in a high-efficiency afterburner. The processed solids are either reused or disposed of as nonhazardous, depending on applicable regulations.

The CBI TDS was evaluated under the SITE Program at the Niagara Mohawk Power Corporation's Remediation Technologies Demonstration Facility at Harbor Point in Utica, New York. Harbor Point is the site of a former manufactured gas plant and has been contami-

nated with coal coking by-products. The list of primary contaminants include: benzene, toluene, ethylbenzene, and xylene (BTEX), polynuclear aromatic hydrocarbons (PAHs), ferricyanide compounds, arsenic and lead. Four different types of MGP solid wastes were tested: (1) coke plant residuals; (2) purifier bed wastes; (3) water gas plant residuals; and (4) Utica Terminal Harbor sediments. The Demonstration Test took place between November 15 and December 13, 1993.

Results from the SITE Demonstration are summarized below:

- The CBI TDS achieved destruction and removal efficiencies (DREs) of 99.99% or greater in all 12 runs using total xylenes as a volatile principal organic hazardous constituent (POHC).
- DREs of 99.99% or greater were achieved in 11 of 12 runs using naphthalene as a semivolatile POHC.
- Average concentrations for critical pollutants in processed solids were (estimated) 0.066 mg/kg total BTEX; 12.4 mg/kg total PAHs; and 5.4 mg/kg total cyanide.
- The CBI TDS showed good operating stability. The range for critical operating parameters was as follows: feed rate, 16 to 22 tons/hr; kiln soil exit temperature, 620 to 860°F; afterburner temperature, 1,810 to 1,820°F; and afterburner residence time, 0.82 to 0.87 seconds.
- Comparison of the dry weight basis concentration of pollutants in the feed and processed solids shows the following average removal efficiencies: (estimated) 99.7% total BTEX; 98.6% total PAHs; and 97.5% total cyanides.
- Although stack emissions were generally in compliance with applicable standards, data show sulfur dioxide emissions were well above statutory limits since the TDS was operating without any air pollution equipment designed for scrubbing.

The CBI TDS technology was evaluated based on the seven technical criteria used for decision making in the Superfund feasibility study (FS) process. Results of the evaluation are summarized in Table 1.

Technology Description

In general, thermal desorption is an ex-situ physical separation technique that transfers contaminants from soil and water to the gas phase. The process uses heat to raise the temperature of organic contaminants enough to volatilize and separate them from a bed of contaminated solid waste. Temperatures are controlled to prevent widespread combustion since incineration is not the desired result. The volatilized organic contaminants can be captured by condensation or adsorption, or destroyed by using an offgas combustion chamber.

The CBI TDS is a direct-fired, co-current thermal desorber based on standard rotary kiln technology. It is a process which is composed of three different operations: feed preparation, contaminant volatilization, and gas treatment.

Feed preparation begins with a sequence consisting of crushing, shredding, and screening to reduce maximum particle size to 3/4-in. The material is then blended by using a front-end loader to repeatedly fold the material onto itself as a precaution against pockets of high BTU content soil and to distribute moisture evenly. This step is important since it helps protect the system from thermal shocks caused by oily "hot spots" in the waste. The prepared material is then placed into feed surge bins and fed into the kiln through a two-stage conveyor belt system.

Contaminant volatilization begins after the prepared feed material enters the kiln. The soil temperature is increased up to ~800°F through contact with an air stream heated by a natural gas burner located at the kiln's entrance. The kiln is equipped with specially designed flights that lift and veil the soil, exposing greater surface area to the hot gases, improving volatilization. Treated soil exits the kiln and enters a pug mill which combines the material with solid residuals from the gas treatment sequence to form a consolidated processed solids stream. Water recycled from the quench tower is added at this time to cool the processed solids and control fugitive dust emissions. The solids are deposited onto a discharge conveyor and stockpiled.

Gas treatment begins when the kiln offgas, now filled with volatilized contaminants and entrained particulate, enters a multi-stage treatment sequence. Kiln offgases are first drawn through a cyclone to remove coarse particulate matter. The gases then enter a high-efficiency, natural gas-fired afterburner which combusts organic constituents at temperatures up to ~1,800°F. A quench tower cools the combustion gases by passing them through a highly atomized water mist. The cooled gas stream then enters a baghouse to remove fine-sized filterable particulate. If any acid levels are high enough to impact air quality standards, a scrubber could be added at this point in the treatment sequence. Treated gases exit the system through a 75-ft high stack. Solid residuals from gas treatment are transferred by a screw auger to the pug mill and are combined with the treated soil from the kiln.

The TDS layout is flexible and facilitates the rearrangement or addition of process equipment, as required. This permits CBI to customize operations based on site-specific combinations of media and pollutants. Figure 1 is a schematic diagram of the CBI TDS unit as configured for the SITE Demonstration Test. The TDS is transportable and is monitored and controlled by a computer-based data acquisition system.

Technology Applicability

In general, the CBI TDS can be applied at any site where the following conditions exist: the target waste can be excavated or dredged readily for processing, target pollutants are amenable to desorption at kiln temperatures with a capacity between 600 and 1,100°F, and gas phase contaminants can be destroyed in an afterburner at temperatures of 2,000°F or less.

CBI states that the TDS is capable of handling a variety of solid waste types including soil, sediment, and sludge. Within each solid waste type, the unit accepts a range of particle sizes, from granular to silty clays. In the SITE Demonstration Test, large chunks of debris were pulverized until the maximum particle size was reduced to 3/4-in. and were then combined with other feed materials for routine treatment. CBI claims that soil containing large proportions of silt or dense clay-like hardpan, tradi-

Table 1. Evaluation Criteria for the CBI TDS

	Criteria						
	Overall Protection of Human Health and the Environment	*Compliance with Federal ARARs**	*Long-Term Effectiveness and Performance*	*Reduction of Toxicity, Mobility, or Volume Through Treatment*	*Short-Term Effectiveness*	*Implementability*	*Cost*
Performance	*Provides both short- and long-term protection by permanently eliminating contaminants in soil.*	*May require compliance with RCRA treatment, storage, and land disposal regulations.*	*Effectively separates organic contamination from soil, and destroys organics in afterburner.*	*Significantly reduces toxicity, mobility, and volume of soil contaminants through treatment*	*Requires measures to protect workers and community during excavation, handling, and treatment.*	*The system has on-line efficiency of 80-90%.*	*$75-190/ton (which is highly dependent on site characteristics)*
	Process controls reduce any unacceptable short-term or cross media impacts.	*Feed preparation, and operation of treatment unit may require compliance with State and ARARs.*	*Involves well demonstrated technique for removal of contaminants.*	*Does not produce any intermediates of greater toxicity as a result of treatment.*	*High throughput rates of technology can reduce overall time for remedial action.*	*Utility requirements are limited to water, electricity, and natural gas or fuel oil.*	
		Emission controls are needed to ensure compliance with air quality standards.	*Involves some residuals treatment or disposal.*	*Treatment is permanent.*		*Technology performance monitored by computer data acquisition system.*	
			Metal bearing wastes not effectively treated.			*Thermal technologies historically have had trouble gaining community acceptance.*	

**ARARs - Applicable or Relevant and Appropriate Requirements.*

tionally a problem for other treatment technologies, have been processed successfully by the TDS.

The CBI TDS was designed to remove volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total petroleum hydrocarbons (TPHs). During the Demonstration Test, the CBI TDS removed VOCs such as BTEX; SVOCs such as naphthalene, phenanthrene, chrysene, benzo(a)pyrene, and other PAHs; and organometallic ferricyanide complexes. CBI claims that other full-scale TDS operations have been used to treat TPHs including gasoline and fuel oils such as No. 2 oil, diesel fuel, kerosene, and, jet fuel.

The CBI TDS does have some limitations with respect to the characteristics of wastes it can treat (see Technology Limitations), and, the process does generate some residuals that require further treatment (see Process Residuals). As such, the technology should not be considered entirely stand-alone.

Technology Limitations

Contaminated feed materials must have a minimum solids content of 60% to facilitate materials handling operations. It should be noted that a high moisture content may reduce throughput only if burner capacity is exceeded. As feed material passes through the kiln, energy is first consumed to heat and vaporize moisture. Significant contaminant volatilization cannot begin until most of the moisture is driven from the feed material. In order to restore desorber throughput, higher burner firing rates or the addition of a separate dewatering step may be required. During the SITE Demonstration, high moisture content feed materials did not appear to have an impact on desorber performance.

CBI advises that the unit has a waste heat value upper limit of approximately 300 Btus/lb. The limit was a conservative estimate designed to ensure temperature stability throughout the system. However, actual conditions during testing introduced waste with heat values in excess of 3,000 Btus/lb. For MGP wastes, the major sources of elevated heating value are oily manufactured gas by-products and wood chips from purifier beds, an outdated stack gas scrubbing process. Waste blending or homogenization is highly recommended as a means to evenly distribute both moisture and Btu content.

Various compounds containing sulfur and cyanide are common in MGP wastes and when treated with this system become a potential source of air pollution. A caustic scrubber may be required to capture the combustion products of these compounds if sulfur and cyanide levels are high enough to exceed health and safety or applicable air quality standards.

Treatment of wastes contaminated primarily with halogenated hydrocarbons can be accomplished with the addition of air pollution control equipment since system temperatures are above the condensation point, preventing corrosion of components. Metals that are not particularly volatile are not likely be treated effectively by the TDS. If there is a need to reduce metals concentration, a separate pre- or post-treatment step will be required. Plastic materials are not recommended for treatment by this process since their decomposition products could cause plugging or foul surfaces.

Process Residuals

The CBI TDS was designed to minimize waste streams by combining or recycling internal process streams wher-

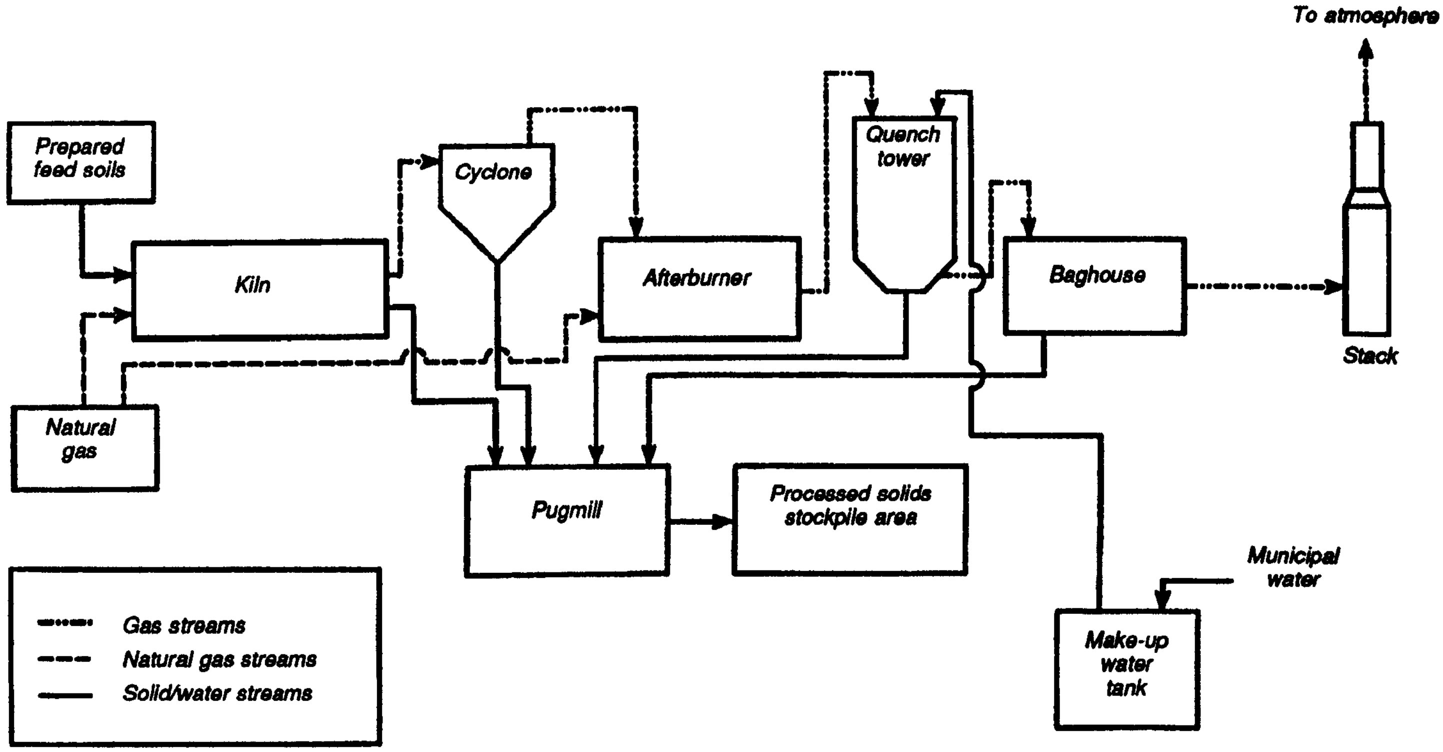

Figure 1. CBI thermal desorption system.

ever possible. For example, excess water from the quench tower is recycled in the system to control fugitive dust emissions. As a result of its design, the TDS generates three residual streams: (1) screened debris rejects, (2) processed solids, and, (3) stack gases.

Screened debris rejects for the Demonstration Test consisted primarily of a low volume of metal scraps, oversized wood pieces, and, articles of plastic. These items are currently stockpiled onsite. Other screened debris were pulverized and combined with feed material for routine treatment.

Internal solid residual streams generated by the TDS are combined to create a single consolidated processed solids stream. The stream consists of particulate removed from the gas treatment sequence and kiln solids. The processed solids are not derived from Resource Conservation and Recovery Act (RCRA) listed wastes and do not exhibit characteristics of hazardous waste as defined in 40 CFR 261. Preliminary results show that the processed solids have met special site-specific treatment standards and are currently stockpiled onsite awaiting use as backfill in future Harbor Point projects.

Stack gas emissions from the TDS were subject to a number of standards during the Demonstration Test including: 40 CFR 50, National Ambient Air Quality Standards (NAAQS); Title 6 New York Codes, Rules and Regulations (NYCRR) Part 257, Air Quality Standards; and New York State Department of Environmental Conservation (NYSDEC) Air Guide 1, Guidelines for the Control of Toxic Ambient Air Contaminants. Results from the Demonstration Test show that average sulfur dioxide emissions were above NYSDEC standards for each MGP waste type tested. The addition of a caustic scrubber would be required for full-scale remediation at this site.

Site Requirements

CBI TDS equipment transportation requirements consist of 15 to 20 legal and oversized truck loads of equipment. Oversized loads requiring permits include: feed bins, kiln, cyclone, afterburner, afterburner stack base, quench top, quench bottom, and, baghouse. For remote sites, access roads will be necessary for equipment transport. Once onsite, the TDS can be fully operational in approximately 1 mo, depending on weather conditions and availability of necessary facilities, equipment, utilities, and supplies. The major components of the system are designed to be off-loaded directly into place. If a suitably constructed floor space is not available, then, at a minimum, concrete footers will be required to support system components at several key locations. Once assembled, the entire system has a footprint measuring 100 x 150 ft (exclusive of materials handling and decontamination areas). For standard operations, the system requires a crew of 6 to 8 people. After treatment is completed the system can be demobilized and moved offsite within one mo.

Utility requirements for the CBI TDS are electricity, water, and natural gas. The TDS requires a three-phase transformer with 1000-ampere, 480-volt service. The following quantities of utilities were used (/ton of soil treated) during the Demonstration Test: water, 320 gal; electricity, 18.3 kilowatt-hr; and natural gas, 0.16 to 0.424 million Btus (based on 1500 to 4000 SCF/ton).

Excavation of one waste type, water gas plant residuals, was accomplished in a prefabricated, fully-enclosed, mechanically-ventilated, temporary structure. The enclosed structure was necessary due to the high level of malodorous volatile compounds in the waste and the proximity of the excavation pit to the surrounding community. Dredging of harbor sediments required construction of a sheetpile excavation cell and installation of a silt curtain to decrease the potential for harm to the aquatic environment. The need for specialized facilities such as these is site specific.

A method to store waste materials prepared for treatment may also be necessary. Storage capacity will depend on waste volume. During the Demonstration Test, several prefabricated structures were used to house prepared feed materials prior to treatment. The structures averted a rain runoff problem and prevented windy conditions from creating a dust hazard. Storage should also be provided to hold the processed materials until they have been tested to determine their acceptability for disposal or reuse.

Onsite analytical equipment capable of determining the residual concentration of organic compounds in feed and treated materials can provide quick-turnaround information on TDS performance. Such equipment and facilities were utilized during the Demonstration Test.

Performance Data

The performance of the CBI TDS was evaluated on four types of MGP solid wastes. These were: (1) coke plant residuals; (2) purifier bed wastes; (3) sediments from the Utica Terminal Harbor; and (4) water gas plant residuals. The four waste types were selected because they represent waste types commonly found at each of the estimated 3,000 former MGP sites located across the nation. Maximum pollutant concentrations were 320 mg/kg BTEX; 4,420 mg/kg total PAHs; 1,120 mg/kg total cyanide; 60 mg/kg arsenic; and 320 mg/kg lead.

Three 4-hr replicate runs were conducted for each waste type. For each run, samples were collected from the feed soil, processed solids, cyclone solids, baghouse solids, quench water, intake water, and, stack gases. Samples were analyzed for PAHs, BTEX, cyanide, and metals. Feed soil samples were also analyzed for other physical and chemical parameters.

Performance criteria established for the Demonstration Test included the following:

- Compare actual DREs against standard of 99.99%.
- Determine concentration of total PAHs, total BTEX, and total cyanide in the processed solids stream.
- Evaluate the stability of targeted operating parameters.
- Calculate removal efficiencies for total PAHs, BTEX, and total cyanide.
- Ascertain whether particulate emissions are within limits established by New York State.
- Match emissions data against New York State Air Guide-1 Toxic Air Contaminants Standards.

Predemonstration sampling and analysis showed that each of the four waste types would require spiking in order to provide pollutant concentrations that were consistent and sufficient to evaluate the DRE performance criterion. A volatile compound (x-ylene) and a semivolatile compound (naphthalene) were selected as POHCs. Each POHC was spiked into the feed stream just before entry into the kiln. DREs were calculated based on emission results, native feed soil concentrations, and POHC spiking rates.

DREs based on total xylenes showed compliance with the 99.99% (or "four nines") standard in each of the 12 runs. Naphthalene DREs were four nines or better for 11 of 12 runs. During the first treatment run of water gas plant residuals, total hydrocarbon analyzers at the stack signaled very large intermittent surges in unburned hydrocarbons. The surges were likely due to oily hot spots in the waste and caused significant disruptions in temperature control at critical locations within the system. The temperature disruptions led to decreased afterburner effectiveness. The hot spots were diagnosed in the field as being a result of deficient waste preparation procedures. Corrective measures were implemented, and subsequent treatment runs achieved four nines performance. DRE results are summarized in Table 2.

Performance goals were not established for pollutant concentrations in the processed solids stream prior to the start of the demonstration due to a lack of full-scale treatability data and an absence of regulatory benchmarks. As such, results from the demonstration were provided to New York State to assist in the development of guidelines for the treatment of MGP wastes by thermal desorption technology. Average concentrations in processed solids were (estimated) 0.066 mg/kg, total BTEX; 12.4 mg/kg, total PAHs; and 5.4 mg/kg, total cyanide. Processed solid concentrations are summarized in Table 3.

Prior to the commencement of the Demonstration Test, a series of experimental runs were conducted in order to optimize several critical operating parameters for each of the four waste types. Operating ranges were established which would provide adequate performance with minimum fuel cost. The following operating parameters were monitored during each run: soil feed rate, kiln soil exit temperature, afterburner exit temperature, and afterburner residence time. Table 4 summarizes average operating conditions.

The system showed good operating stability with all waste types, as indicated by the relative standard deviation (RSD) of each data set. The range of RSDs for each operating parameter is given in Table 4. However, treatment of the harbor sediments and water gas plant residuals provided some notable lessons. Both materials had a tendency to adhere to conveyor belt and feed hopper surfaces, requiring a labor-intensive effort to produce an even flow of feed to the kiln. Additional moisture released in the kiln from the harbor sediments caused kiln temperatures to fluctuate. Pockets of contaminants in water gas plant residuals affected afterburner temperatures by creating nonuniform fuel introduction and upsets to afterburner control loop, impacting afterburner efficiency.

Removal efficiencies for BTEX, PAHs, and cyanide were determined by comparing the dry weight concentration of pollutants in the native feed soil and the processed solids. Average removal efficiencies were: (estimated) 99.7%, total BTEX; 98.6%, total PAHs; and 97.5%, total cyanides. If the spiking levels were considered, these reductions would be greater. Removal efficiencies are summarized in Table 3. Total BTEX, total PAHs, and total cyanide concentrations in feed soil and processed solids are illustrated in Figures 2 through 4.

Particulate emissions from the unit are subject to limits established in 6 NYCRR Part 212: General Process Emissions Source. For all 12 runs, particulate emissions met the applicable State emission limit of 0.050 grains/dry standard cubic foot (gr/dsft^3) corrected to 7% oxygen.

The NYSDEC requires a toxic ambient air quality impact analysis for all new or modified sources of air contaminants regulated under 6 NYCRR Part 212. The analysis, which is described in New York Air Guide-1, was conducted to predict the point of maximum concentration. A standard point source method was used to predict the site of maximum impact. As a conservative and simple approximation, the effective stack height was assumed to be the physical stack height. Building cavity impacts were not considered because emissions are confined to onsite receptors. Worst-case annual and short-term ambient impacts were calculated for all toxic emissions emitted from the TDS then compared to the appropriate guideline concentration to assess the acceptability of the source. For all air contaminants but one, the predicted worst-case impact was less than the concentration listed in the New York Air Guide 1. Arsenic emissions exceeded the annual guideline concentration during coke plant waste treatment runs, and both the annual and short-term guideline concentrations were exceeded during purifier bed wastes treatment runs. Since this basic screening analysis showed a higher than acceptable impact, a more refined air quality analysis should be conducted to accurately predict the site of maximum concentration.

***Table 2.** Destruction and Removal Efficiences*

Waste Type	*Run*	*DRE Total Xylenes*	*DRE Naphthalene*
Coke Plant	*1*	*99.990 %*	*99.998 %*
	2	*99.994*	*99.998*
	3	*> 99.9992*	*99.998*
Purifier Wastes	*1*	*99.993*	*99.998*
	2	*99.997*	*99.9992*
	3	*99.998*	*99.9990*
Harbor Sediments	*1*	*99.994*	*> 99.997*
	2	*99.997*	*> 99.997*
	3	*99.997*	*99.9996*
Water Gas Plant	*1*	*99.998*	*99.97*
	2	*99.998*	*99.998*
	3	*99.998*	*99.9997*

***Table 3.** Input/Output Solids Concentrations and Removal Efficiencies*

Waste Type	*Feed Soil Concentration (Mg/kg)*	*Processed Solids Concentration (mg/kg)*	*Removal Efficiency (%)*
		BTEX	
Coke Plant	*13*	*0.056*	*99.6*
Purifier Wastes	*15*	*0.071*	*99.6*
Harbor Sediments	*81*	*0.065*	*99.9*
Water Gas Plant	*320*	*0.073*	*99.8*
Average			*99.7*
		PAHs	
Coke Plant	*320*	*13*	*95.9*
Purifier Wastes	*1040*	*5.1*	*99.5*
Harbor Sediments	*1620*	*5.5*	*99.7*
Water Gas Plant	*4420*	*26*	*99.4*
Average			*98.6*
		Total Cyanides	
Coke Plant	*730*	*21*	*97.1*
Purifier Wastes	*1120*	*0.24*	*99.9*
Harbor Sediments	*9.3*	*0.23*	*97.5*
Water Gas Plant	*4.3*	*0.2*	*95.4*
Average			*97.5*

It should be noted that metal emissions, including arsenic, would vary depending on such factors as input concentration, metals species, waste matrix, organic constituents and chlorine content. Emission estimates for other waste streams treated by the TDS cannot be extrapolated from the demonstration results and site-specific calculations would need to be performed to determine ambient impacts. Upon examination of these ambient impacts, operating temperature, air pollution control equipment operating parameters, and, waste stream characteristics need to be analyzed to determine how best to control metal emissions.

A continuous emissions monitor (CEM) was used to measure oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbons, nitrogen oxides (NOx), and, sulfur dioxide (SO_2). NYSDEC currently has no emission limits for any of these pollutants except SO_2. The CEM recorded levels of SO_2 above regulatory standards during all runs. Because of the short duration of the Demonstration Test, NYSDEC allowed the system to operate without a scrubber. However, NYSDEC would require a scrubber to control SO_2 emissions if the CBI TDS was selected to remediate this site. Stack emissions are summarized in Table 5.

Table 4. Average Targeted Operating Parameters

Parameter	Coke Plant	Purifier Wastes	Harbor Sediments	Water Gas Plant	RSD Range (%)
Feed Rate (tons/hr)	18	22	16	16	3.4 - 9.7
Kiln Exit Temperature (°F)	620	860	780	820	0.9 - 4.9
Afterburner Exit Temperature (°F)	1810	1810	1810	1820	0.1 - 0.9
Afterburner Residence Time (seconds)	0.86	0.87	0.82	0.84	1.1 - 1.9

Table 5. Average Stack Emisssions Data

		Coke Plant	Purifier Wastes	Harbor Sediments	Water Gas Plant
Particulate	gr/dsft^3	0.025	0.026	0.042	0.041
	lb/hr	2.66	3.18	5.46	5.03
Lead	µg/m^3	17.0	76.5	13.4	34.3
	lb/hr	0.0011	0.0047	0.0009	0.0021
Arsenic	µg/m^3	10.7	39.2	5.7	6.3
	lb/hr	0.0007	0.0024	0.0004	0.0004
CO*	ppm	< 1	3	< 1	5
	lb/hr	< 0.1	0.2	< 0.1	0.4
Total Hydrocarbons*	ppm	6	1	< 1	1
	lb/hr	0.7	0.1	< 0.1	0.1
NO_x*	ppm	88	91	101	121
	lb/hr	10.8	10.5	12.3	14.6
SO_2*	ppm	125	1020	118	353
	lb/hr	21.4	165	20.1	59.0

Physical analyses of the feed materials show that the CBI TDS was able to process different soil types with no discernable effect on performance. The soil types ranged from silty harbor sediments (39% silt/clay) to highly granular purifier bed wastes (89% sand/gravel).

Information on capital and utility costs are preliminary. Based on preliminary data, treatment costs range from $75 - $190/ton. These costs are highly dependent on materials handling operations, contamination type, level, and volume of soil treated.

Technology Status

CBI treated approximately 1,500 tons of waste during the Demonstration Test and an additional 6,600 tons during other tests at Harbor Point outside the scope of this SITE project. All 8,100 tons of treated materials have met special site-specific NYSDEC treatment standards and are currently stockpiled onsite.

The CBI TDS unit used for the SITE Demonstration Test is a modified version of CBI's Soil Recycling Unit (Re•Soil) in North Adams, MA. The Re•Soil system includes a rotary kiln, cyclone, quench, baghouse, and afterburner. Since 1989 the Re•Soil unit has been used to treat petroleum-contaminated soil from various sites throughout the northeast. Soil is transported to Re•Soil's permanent location where it is thermally decontaminated and reused as landfill cover. To date 250,000 tons of contaminated soil have been treated. The unit treats a variety of soils, granular to clay-like, and contaminants include gasoline and fuel oils such as No. 2 oil, diesel fuel, kerosene, and jet fuel. The Re•Soil unit is permitted to operate at a maximum of 100 tons per hour. Processed soils have been in compliance with Massachusetts Department of Environmental Protec-

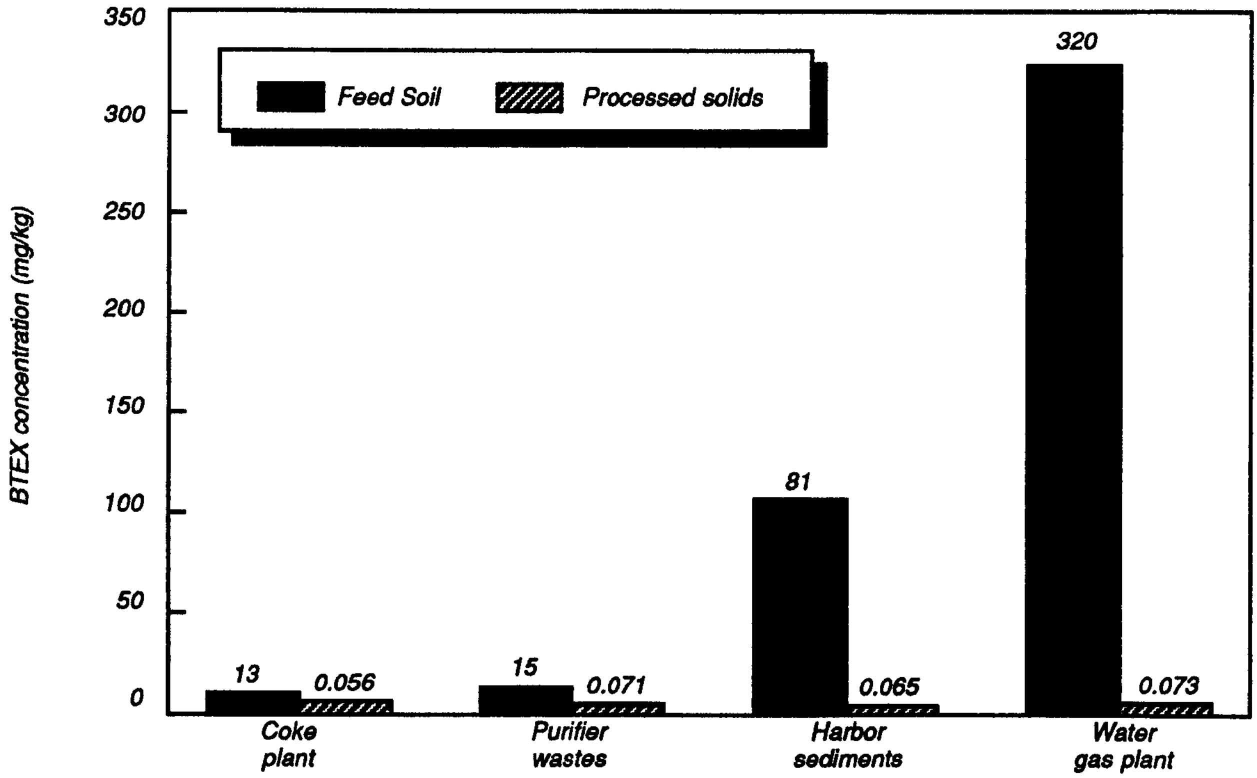

Figure 2. *Average BTEX concentrations in feed soil and processed solids.*

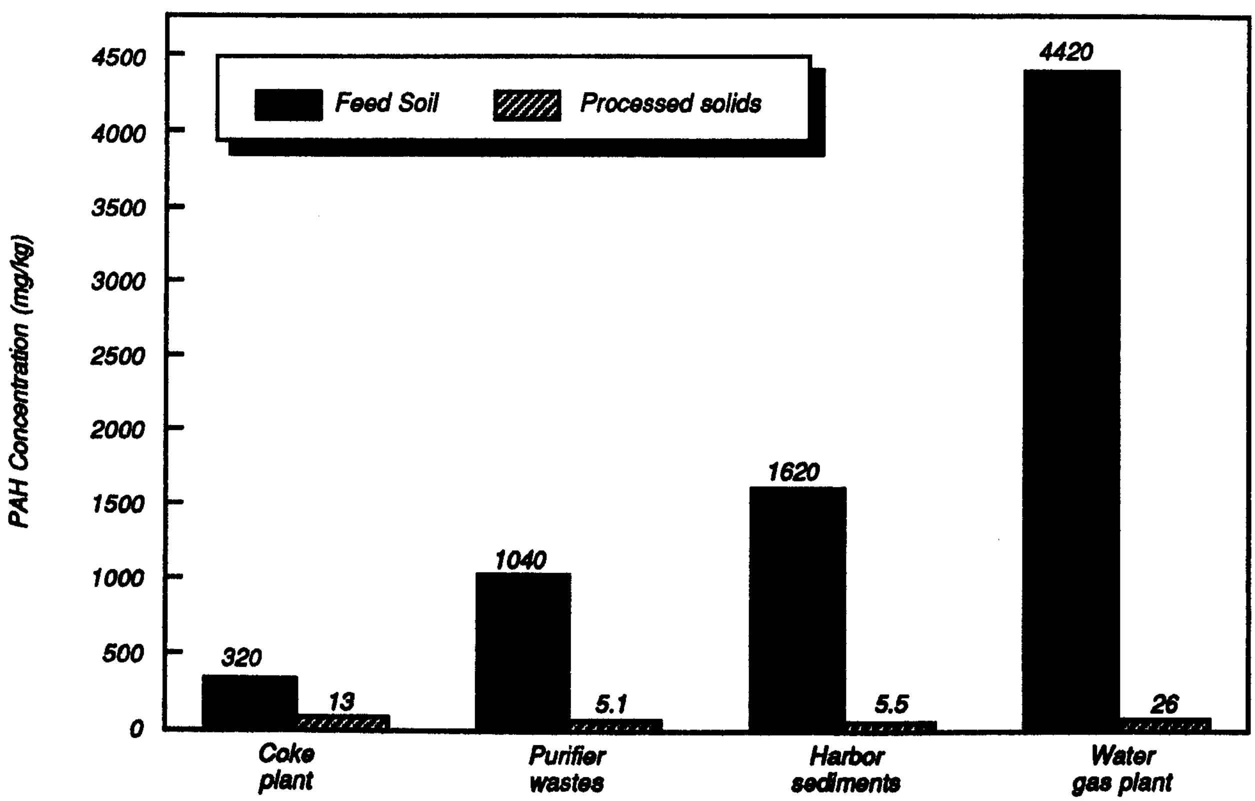

Figure 3. *Average PAH concentrations in feed soil and processed solids.*

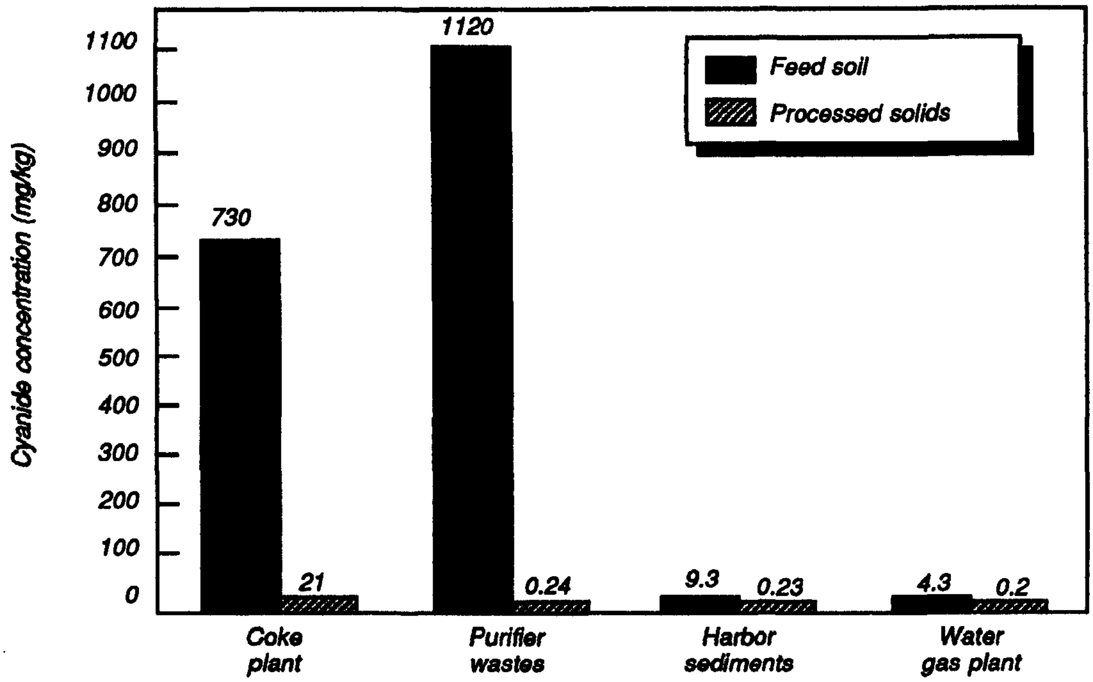

Figure 4. Average cyanide concentrations in feed soil and processed soils.

tion soil clean-up requirements, and compliance tests for emissions have demonstrated a DRE in excess of 99%.

CBI has also designed and built a High Temperature Thermal Incinerator (HTI) which it operates currently at a PCB-contaminated site. The HTI includes a rotary kiln, cyclone, afterburner, first quench, baghouse, second quench, and packed bed scrubber. Approximately 50,000 tons of contaminated soils have been remediated. The soil is primarily silty clay or dense clay-like hardpan and is contaminated with up to 594,000 ppm polychlorinated biphenyls (PCBs) and up to 86,000 ppm VOCs. The HTI is permitted to operate at approximately 52 tons/hr and consistently operates at 42 to 46 tons/hr. Processed soils to date have had PCB concentrations below 0.5 ppm and particulate emissions below the 0.015 gr/dsft^3 requirement. Hydrochloric acid (HCl)/chlorine (Cl_2) emissions are 0.072 lb/hr.

Disclaimer

Although the technology conclusions presented in this report may not change, the data has not been reviewed by the EPA Quality Assurance/Quality Control office.

Source of Further Information

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