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LETTER FROM U S AIR FORCE REGARDING DEMONSTRATION OF SITE RESTORATION TECHNOLOGIES NCBC GULFPORT MS
12/13/1984
U S AIR FORCE

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE ENGINEERING AND SERVICES CENTER
TYNDALL AIR FORCE BASE, FL 32403

DEC 13 1984

REPLY TO ATTN OF: RDVW

SUBJECT: Demonstration of Site Restoration Technologies at the Naval Construction Battalion Center (NCBC), Gulfport MS

TO: Commanding Officer
NCBC
Gulfport MS 39501
ATTN: Code 400

1. HQ AFESC/RDVW and EG&G, Idaho, the Air Force prime contractor, have selected promising environmental restoration technologies for demonstration on the former Herbicide Orange storage site at the NCBC. Test plots at NCBC will be selected based on dioxin concentration and will be either 20 by 20 feet or 40 by 40 feet.

2. The following technologies have been selected:

a. Thermal desorption/UV destruction.

b. High temperature fluid wall reactor.

c. Chemical neutralization.

A point paper is attached describing each technology. This specific effort does not include the joint AF/EPA test of the Alkaline Polyethylene Glycol reagent since it is covered by a separate program.

3. These site demonstrations will be funded with monies from the Defense Environmental Restoration Program. Constraints placed on these funds necessitate completion of the site demonstrations by 30 Sep 85. In order to complete the proposed demonstrations within the stated time line, it is imperative that subcontracts be awarded NLT 1 Feb 85.

4. Since the timing of this project is critical, it is imperative that HQ AFESC/RDVW obtain the Navy's concurrence at the earliest possible date. Capt Stoddart will visit NCBC on 21 Dec 84 to brief the technologies selected. It would be highly desirable to obtain Navy concurrence at that time.

ROBERT F. OLFENBUTTEL, Lt Col, USAF, BSC
Chief, Environics Division

3 Atchs
Point Papers (3)

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SITE DEMONSTRATION

Thermal Desorption/U.V. Destruction

Technology Summary

The thermal desorption process involves passing the contaminated soil through a thermal treatment unit operating at temperatures around 500°C. By the process of evaporation, dioxin and other organics are volatilized, collected in an organic solvent, and destroyed by U.V. photolysis.

Scientific Support

The proposer of this technology has conducted studies that indicate that at temperatures of 500°C with a 30 minute residence time, 2,3,7,8-TCDD is removed from soils to non-detectable levels with detection levels set at less than 50 parts per trillion.

The U.V. destruction of dioxin was proven to be feasible via a full scale cleanup of still bottom wastes containing 2,3,7,8 TCDD. The proposer of this demonstration states that the U.V. process is the only TCDD destruction process permitted on a commercial scale.

Description of Thermal Desorption Process

Contaminated soil will be collected, crushed to proper size if necessary, and placed in storage drums. This material will be fed at a controlled rate by a screw feeder into a rotary drum unit that is heated on the shell of an external gas fired furnace. The drum rotation speed and slope are controlled to provide the required soil residence time. The treated soil discharged from the drum is collected in a closed drum. The soil test feed rates probably will be in the range of 20 to 50 pounds per hour.

The rotary drum is kept under slight negative pressure and is swept continuously with a recirculated nitrogen gas stream to carry off the desorbed materials. The carrier gas is quenched and scrubbed by a cooled, recirculated stream of a high boiling hydrocarbon solvent to remove the desorbed materials. Any build-up of the carrier gas due to inleakage or soil material decomposition will be vented through an activated carbon bed. The carrier gas will also be monitored for oxygen content. Solid fines that collect in the quench solvent will be filtered for spearation and analysis.

The hydrocarbon solvent will accumulate desorbed material from several desorption tests before being processed for organic destruction. When the hydrocarbon solvent is adequate-14 loaded, it will be batch processed in the UV photolysis reaction by recirculation. Treatment time is expected to be about 24 hours.

After each desorption test, any accumulated water in the quench solvent will be separated and treated with activated carbon.

Quantity of Soil to be Tested

- Rate of 20-50 lbs/hr.

- Between 1,000 and 2,500 lbs of soil will be processed.

  -- Time on site, approximately 3 weeks.

HQ AFESC/RDVW
Capt Stoddart/AUTOVON 970-2942
12 Dec 84

SITE DEMONSTRATION

High Temperature Fluid Wall Reactor (HTFWR)-(AER)*

Technology Summary

The HTFWR uses a technology which rapidly heats feed materials to temperatures in the range of 4000° to 4500°F, with surface heating rises up to 10^7°F per second using intense thermal radiation in the near infrared region. Feed stock is isolated from the reactor core by means of a nitrogen blanket. Pyrolysis occurs since no oxygen is present.

Process Description

The solid feed is gravity fed through the reactor where pyrolysis occurs. After leaving the reactor, the product gas and waste solids pass through a post-reactor treatment zone (PRTZ). Solid and gas phase residence times for both the reactor and the PRTZ can be independently varied to achieve essentially any desired destruction efficiency. The PRTZ is water cooled and provides additional residence time; however, its primary function is to cool the molten soil particles below their fusion temperature to avoid coagulation in the treated solid waste bin and to cool the gas prior to downstream particle cleanup.

The detoxified solid material exiting the PRTZ is, for the most part, collected in a solids bin which is sealed to the atmosphere. The off-gas is then conveyed to a bag filter for removal of any remaining fine soil residuals.

The process gas cleaning train consists of activated carbon beds for the removal of any trace level residual chlorine or organics. The cleaned gas (composed almost entirely of nitrogen and water vapor) is then emitted to the atmosphere. The low process gas flow rate (about 5 scfm) economically allows the high degree of cleanup that is described here.

Scientific Justification

The PCB Trial Burn, performed in September 1983, detoxified approximately seven tons of solids. In this test, Arochlor 1260 was mixed with sand to form a solid feed waste containing approximately 3000 ppm PCBs. In May 1984, another test series was conducted using carbon tetrachloride, a very refractory (i.e., hard to thermally destroy) substance, over a wide range of test conditions. In both of the above tests, no test yielded results below 99.9999 percent destruction and removal efficiency (DRE).

The AER has also demonstrated its ability to detoxify dioxin-contaminated soils. In October 1984, the AER processed soils contaminated with a laboratory-prepared, heavily chlorinated dioxin--octachlorodibenzo-p-dioxin (OCDD)--a surrogate for TCDD. In November 1984, the AER detoxified soil contaminated with the 2,3,7,8 tetrachloro isomer of dioxin on location in Times Beach, Missouri. In both of these tests the results of the dioxin analysis for the treated soil and stack gases indicated that these streams may be considered non-hazardous; i.e., no dioxin was detected in any of the streams. Typically, the solids detection limits were 0.1 ppb for both OCDD and TCDD. EPA uses a 1.0 ppb TCDD level for "delisting" dioxin soils.

Quantity of Soil to be Processed

- 1,000 lbs
  - -- Time on site, a maximum of 10 days.
  - -- Process rate, 100 lbs/hr.

(*AER = Advanced Electric Reactor. Term used same as HTFWR.)

HQ AFESC/RDVW
Capt Stoddart/AUTOVON 97[illegible]12
12 Dec 84

SITE DEMONSTRATION

In Place Treatment by Chemical Methods

Technology Summary

This in situ treatment process involves the direct contact of the Alkaline Metal Polyglycoxide and additives to 2,3,7,8 TCDD. The strongly nucleophilic reagent displaces chlorine atoms on the dioxin ring; increasing solubility and decreasing toxicity.

Scientific Support

The ability of sodium and potassium polyalkoxides and radical additives to displace chlorine atoms from aromatic halides such as polychlorinated biphenyls has been demonstrated. The similar reaction has been verified on TCDD and on TCDD-contaminated materials from the Icmesa plant of Seveso, Italy. These reactions proceed near ambient conditions, in the presence of reasonable concentrations of water, and, most importantly, yield reaction products that are nontoxic.

The reagent consists of three major components:

- A polyglycol copolymer of ehtylene oxide (EO) and propylene oxide (PO) in the range of molecular weight, i.e., a sodium salt of a reagent of molecular weight 6000 gives a nucleophilic displacement rate about 10 times faster than tetraethylene glycol. The viscosity of the reagent varies with molecular weight so that the reagent can be adapted to tasks that require varying degrees of penetration into solid surfaces. For example, one of those reagents penetrates concrete and appears to be suited particularly well for testing on the coral rocks at JI.

- A base that may be MOH (sodium or potassium hydroxide) or M_2CO_3, the corresponding carbonate.

- A radical source such as sodium peroxide at 1-5 percent w/w, or ultraviolet radiation. In the case of reactions with solids, penetrating agents such as those used in pesticide formulations are added.

Destruction of Polychlorinated Biphenyls (PCBs) -- Sixteen ml of mineral oil containing 20,000 ppm PCB was placed into a 50-ml flask. To the solution, maintained at 85°, was added 2.0 g of carbowax-6000, 0.5 g of potassium carbonate, and 0.2 g of sodium peroxide. The mixture was stirred magnetically for 3 hours, cooled, and analyzed by capillary GC/EC. The residual PCB concentration was 95 ppm, a reduction of 99.5 percent.

In similar experiments, 0.1 ml (4 percent) and 0.3 ml (11 percent) of water was added. The addition of 4 percent of water to the reagent had little effect on the reaction rate, yielding a residual PCB concentration of 140 ppm, a 99.3 percent reduction. The addition of 11 percent water to the reagent decreased the reaction rate to yield a residual PCB concentration of 1380 ppm. However, 93.1 percent reduction was effected.

Destruction of TCDD in Solvent -- A solution of 4.0 ml of n-decane containing 4 ppb of 2,3,7,8-TCDD was stirred for 2 hours at 85° in the presence of 1.0 g of carbowax-6000, 0.5 g of potassium carbonate, and 0.1 g of sodium peroxide. Analysis by GC-MS detected no residual TCDD, a destruction of 98 percent. These data confirm that TCDD decomposition occurs readily at 50° in solution but that room temperature reactions are slower as expected.

Destruction of TCDD in Solids -- Destruction of TCDD in solids by the AMPA reagent has been tested on contaminated metal pipe and soil from Seveso. A piece of pipe, 4 inches in diameter and 4 inches long, from the discharge of the Icmesa plant vent condenser, showed brown incrustration on the inner surface and contained 3.73 ppm TCDD plus trichlorophenol and other reaction products from the exothermic reaction. The pipe was immersed in a vessel containing 400 g of AMPA reagent. The mixture was stirred by ultrasound for 5 hours at 55°. At the end of this period, the pipe's visible incrustration had disappeared, and the total residual TCDD concentration was 0.09 ppm, a destruction of 97.5 percent.

Soil from Seveso Zone A, 263 g, containing 513 ppt of TCDD, was stirred with 977 g of AMPA reagent for 6 hours at 85°. The soil's dioxin concentration was 97 ppt, 81 percent destruction.

Reaction Products -- Knoweldge of reaction products and their toxicological environmental impact is crucial to any dioxin destruction process.

To a mixture of 12.5 g of AMPA reagent at 80° was added 2 mg of TCDD. Samples were taken at 5 minutes, and 1,2,3, and 5 hours for chemical analysis, and at 60, 105, and 300 minutes for toxicological analysis.

Chemical analysis after 5 minutes of reaction showed products of progressive dechlorination, moni-, di-, and trichlorodibenzodioxins plus TCDD. After one hour, trace amounts of chlorinated dioxins were observed in addition to nonchlorine containing peaks at m/e = 647 and 662, presumably glycol condensation products. Thus, the reaction appears to proceed by two pahtways, reductive dechlorination presumably via radical intermediates and nucleophilic substitution presumably via alkoxides.

Toxicological testing was carried out by H. Poiger at the Federal Institute of Technology, Switzerland, using male guinea pigs. Animals were dosed by gavage, weighed at appropriate intervals, and checked for toxic signs before and after sacrificing. The conclusions from this experiment are:

"Neither the typical signs of intoxication with chlorinated dioxins, like retardation of growth or decreased thymus weight, nor other toxic signs were observed within the experimental period. This was at does levels of 431 and 661 cmg of "TCDD-equivalents"/kg body weight. The acute toxicity LD_{50} TCDD in the guinea pig is at approximately 1 cmg bw (0.6 and 2 cmg bw have been reported). In view of this absence of any sign of acute toxicity at 431 and 661 fold dose level (of the degradation products) it can be assumed that the LC_{50} of these products is higher than 660 cmg/kg bw."

These results demonstrate significant decrease in toxicity of TCDD upon treatment with AMPA reagent.

Quantity of Soil to be Tested

√ - 10 x 20 foot plot

-- Time on site, approximately 30-45 days.

HQ AFESC/RDVW
Capt Stoddart/AUTOVON 970-2942
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