DIOXIN DESTRUCTION WITH APEG-PLUS™ CHEMICAL DECHLORINATION

ROBERT L. PETERSON, P.E.
STEPHEN L. NEW
GALSON REMEDIATION CORPORATION
6627 JOY ROAD
E. SYRACUSE, NY 13057
U.S.A.

ABSTRACT

Alkaline dechlorination has proven to be an effective method of destroying dioxin in soils and sludges. Reduction to <1ppb can routinely be obtained.

INTRODUCTION

APEG-PLUS alkaline dechlorination is a chemical method for the destruction of dioxins. The method offers many advantages including the absence of emissions, non toxicity of end products, and reuse of the treated soil as backfill on the site.

CHEMISTRY

One of the most recent European and U.S. patents in the dechlorination area (1), uses a combination of polyethylene glycol (PEG) and an aprotic co-solvent (dimethyl sulfoxide) to decompose dioxin and other aromatic halides (PCBs, pentachlorophenol, chlorinated herbicides and pesticides) in contaminated soils and sludges. In the patented Galson process (1,2,3), contaminated solids are mixed with a reagent consisting of potassium hydroxide in a solution of mixed PEG and dimethyl sulfoxide (DMSO). The reagent mixture extracts the dioxin from the soil particle; dehalogenation (4,5) of dioxin follows, forming a glycol ether. Clean up levels of <1 part per billion (ppb) for dioxins and <2 parts per million (ppm) for PCBs can be achieved in virtually any soil matrix.

TOXICITY

Dimethyl sulfoxide and polyethylene glycol are essentially non toxic materials. The reaction of the glycol with the aromatic dioxin or PCB ring introduces an electron-donating substituent to the ring, producing a water-soluble, low-toxicity material. Toxicity testing by the USEPA indicates that the replacement by polyethylene glycol of a single chlorine on a dioxin or PCB molecule produces a material which is low in toxicity (LD50

> 5,000 mg/kg) and does not appear to bioaccumulate or cause mutagenic effects (6).

DIOXIN CASE HISTORIES USING APEG-PLUS™

The APEG-PLUS™ dechlorination process has been used at a variety of sites to remediate soils and sludges contaminated with dioxins, as summarized in the table below:

Site	Dates	Contaminant	Comments
AmTech Indiana (USA)	1988	dioxin sludge	9500 liters from 11,000,000 ppb to < 1ppb PCDD
Signo Trading New York (USA)	1987	dioxin sludge	1 drum TCDD material to < 1 ppb PCDD
NCBC Arkansas (USA)	1987	dioxin soil	pilot test:dioxin from 350 ppb to < 10 ppb PCDD
Montana Pole Montana (USA)	1986	dioxin oil	34,000 liters from 100,000 ppb to < 1 ppb PCDD
Western Processing Washington (USA)	1986	dioxin oil	21,000 liters with 15% water to < 1 ppb PCDD

Other dechlorination demonstrations have been conducted under the sponsorship of the USEPA Risk Reduction Environmental Laboratory in Cincinnati, Ohio (USA), (7).

EQUIPMENT

A full-scale soils decontamination unit has been designed and constructed. Mobile and modular systems can be assembled to remediate at rates of 20, 80, 200 or more metric tons of soil per day. Field scale testing is planned to take place in mid-1990. Application of this unit on a dioxin contaminated site is expected in the third or fourth quarter of 1990.

Following on-site assembly of the mobile and modular unit, the APEG-PLUS™ treatment system is ready to receive excavated soil or sludge. The process is initiated by loading nine metric tons of soil, sieved to 0.6 centimeter, into a 11,000 liter, closed, slurry mixer tank. A volume of five-thousand kilograms of reagent, consisting of polyethylene glycol, potassium hydroxide, and dimethyl sulfoxide is then pumped into the closed mixer tank and is mixed with the soil to create a slurry. The slurry is pumped to a closed reactor vessel where temperature is brought to 150° C.

Treatment times per batch may range from 4-12 hours depending on the soil matrix and the type of contaminant(s) present. An automated, remote sampling device is used to draw a sample of the treated soil while it is still in the closed reactor. This sample is then taken to an on site field laboratory where EPA method 8280 (with detection limit of 300 ppt dioxin) is used to verify that the waste has been treated to the specified clean up level (8). Once the instrument has determined that the required treatment standard has been met, the slurry is pumped to the centrifuge.

Centrifuge processing begins by spinning out the reagent, which is then transferred to a triple effect evaporator for reagent recovery, followed by refortification and use on the next soil-slurry batch. After the reagent has been recovered, the soil undergoes multiple wash water rinses in the centrifuge. The wash water is also recovered for re-use through the reagent recovery system. With completion of the rinsing, the soil is clean and decontaminated. It can be conveyed out of the centrifuge and used for clean backfill on the site. Air discharge and emission concerns associated with incineration are not a consideration with this system. As a result, public acceptance has been very favorable.

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