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EPA A Citizen's Guide To Glycolate Dehalogenation

Technology Innovation Office _____ **Technology Fact Sheet**

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What Is Glycolate Dehalogenation?

Glycolate dehalogenation is the process of using a *chemical reagent* (a glycol in this case) to remove halogen from contaminants, consequently rendering them less hazardous. A *chemical reagent* is a substance used to react with and change another substance. This dehalogenation process can be used on halogenated contaminants such as PCBs and dioxins that may be found in soil and oils.

One chemical reagent that removes halogen is called an APEG reagent. It consists of two parts: an alkali metal (hence the A in APEG) and Polyethylene Glycol (PEG), which is a substance similar to antifreeze. Alkali metals, such as sodium and potassium, have basic (high pH) properties, as do ammonia and milk of magnesia.

A conceptual diagram of dehalogenation is shown in Figure 1. The process is illustrated in greater detail on page 3 and the following discussion.

What Are Halogens?

Halogens are non-metallic elements such as Chlorine, Bromine, Iodine, and Fluorine. Halogens are incorporated into larger chemical structures to form halogenated compounds. Companies manufacture halogenated compounds because they provide a variety of uses for humans. For example, one type of halogenated compound, polychlorinated biphenyls (PCBs), was once used in high voltage electrical transformers because it conducted heat well while being a good electrical insulator. In addition, halogenated compounds are used to produce pesticides because their addition causes the toxicity needed to control pests. Halogenated compounds are also commonly used in water treatment, swimming pools, plastic piping and textiles, among other materials.

Glycolate Dehalogenation Profile

- **Mainly used to treat halogenated aromatic organic contaminants, particularly PCBs and dioxins.**
- **Chemically converts toxic materials to less toxic materials.**
- **Involves heating and physically mixing contaminated soils with chemical reagents.**
- **Is a transportable technology that can be brought to the site.**

Produced by the Superfund Program

How Does It Work?

A contaminant being treated with glycolate dehalogenation undergoes five major phases, which are shown in Figure 2 on page 3. These five phases are **preparation, reaction, separation, washing,** and **dewatering.** During the first phase, the contaminated waste is dug up and moved to a staging area — a place where the contaminated material is prepared for treatment. The waste is then sifted to remove debris and large objects, such as boulders and logs. Contaminated soils and the APEG (Alkaline PolyEthylene Glycol) reagent are then put into a treatment vessel where they are heated and mixed to form a sludge. The heating helps the PEG part of the APEG reagent replace some of the halogens in the halogenated compound. The halogen and the A part of the APEG reagent chemically combine to form a salt. This reaction is shown in Figure 1.

During the heating process, some volatile air emissions, which may be contaminated, are given off. These vapors are collected in a condenser, where they are separated into water and air emissions. The water can be used during a later step in the process, while the air emissions are captured by activated carbon filters. These filters are then transported off-site for either regeneration, incineration, or disposal into an environmentally safe landfill regulated by the Resource Conservation Recovery Act (RCRA) or the Toxic Substance Control Act (TSCA). A slurry—less toxic wet mixture of soil and APEG reagent—is the result of the reactor phase.

The resulting slurry then goes to the separator, where the APEG reagent is physically separated and recycled for future use in the treatment vessel. The soil contains the by-products of the dehalogenation reaction and some residual APEG reagent. **These by-products (shown in Figure 1) are a halogen salt, which consists of an Alkali metal (A) and a halogen, and a partially halogenated compound.** This partially halogenated compound does not accumulate in living tissue and is therefore less hazardous than the original compound which does accumulate in living tissue.

The soil then goes to a washer, where the water from the condenser is added. The residual APEG reagent is extracted from the soil and recycled. The glycolate dehalogenation treatment can make the soil basic because of the addition of the APEG reagent which has basic properties. Therefore during the washing phase, acid is added in order to neutralize the soil. Neutralization reactions involve mixing acids and bases in appropriate amounts in order to get a compound that is neither highly basic (high pH) or highly acidic (low pH).

The soil then goes to a dewatering phase where the water and soil are separated. The water is treated until it meets the appropriate pollution levels set forth by the local National Pollutant Discharge Elimination System. When the water is free of contaminants, it can be discharged to a Publicly Owned Treatment Works, a receiving stream, or other appropriate discharge areas. The soil is tested for contaminants. Following testing, the soil is either retreated, redeposited, or put into an environmentally safe RCRA or TSCA landfill.

What Is An Innovative Treatment Technology?

Treatment **technologies are processes applied to the treatment of hazardous waste or contaminated materials to permanently alter their condition through chemical, biological, or physical means. Technologies that have been tested, selected or used for treatment of hazardous waste or contaminated materials but lack well-documented cost and performance data under a variety of operating conditions are called** ***innovative*** **treatment technologies.**

Figure 1
Conceptual Diagram of Dehalogenation

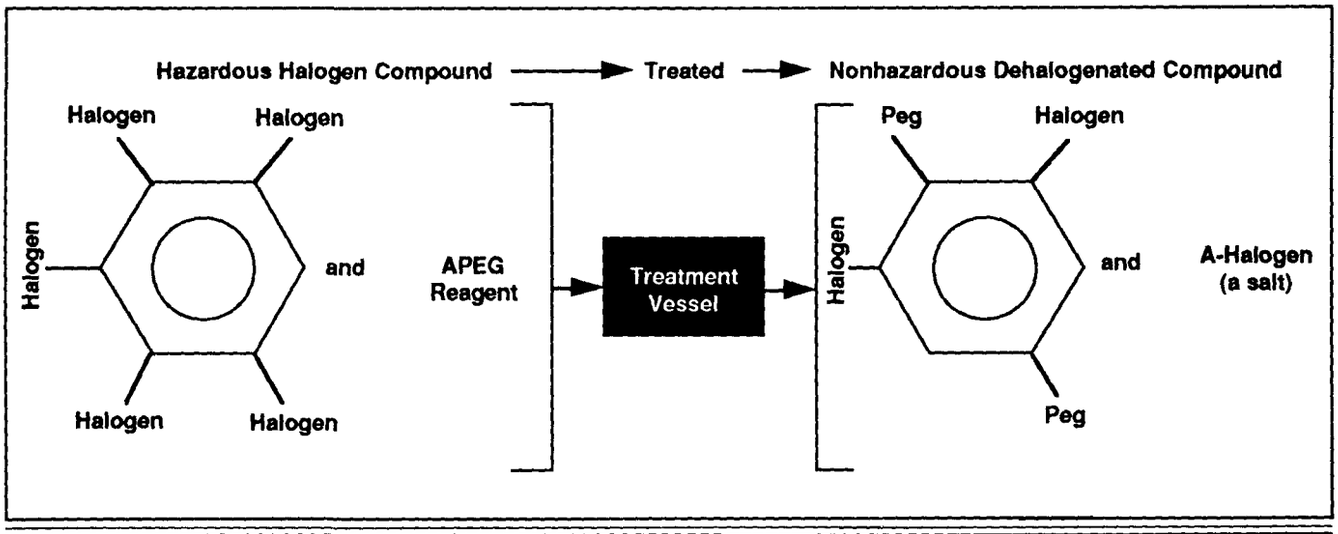
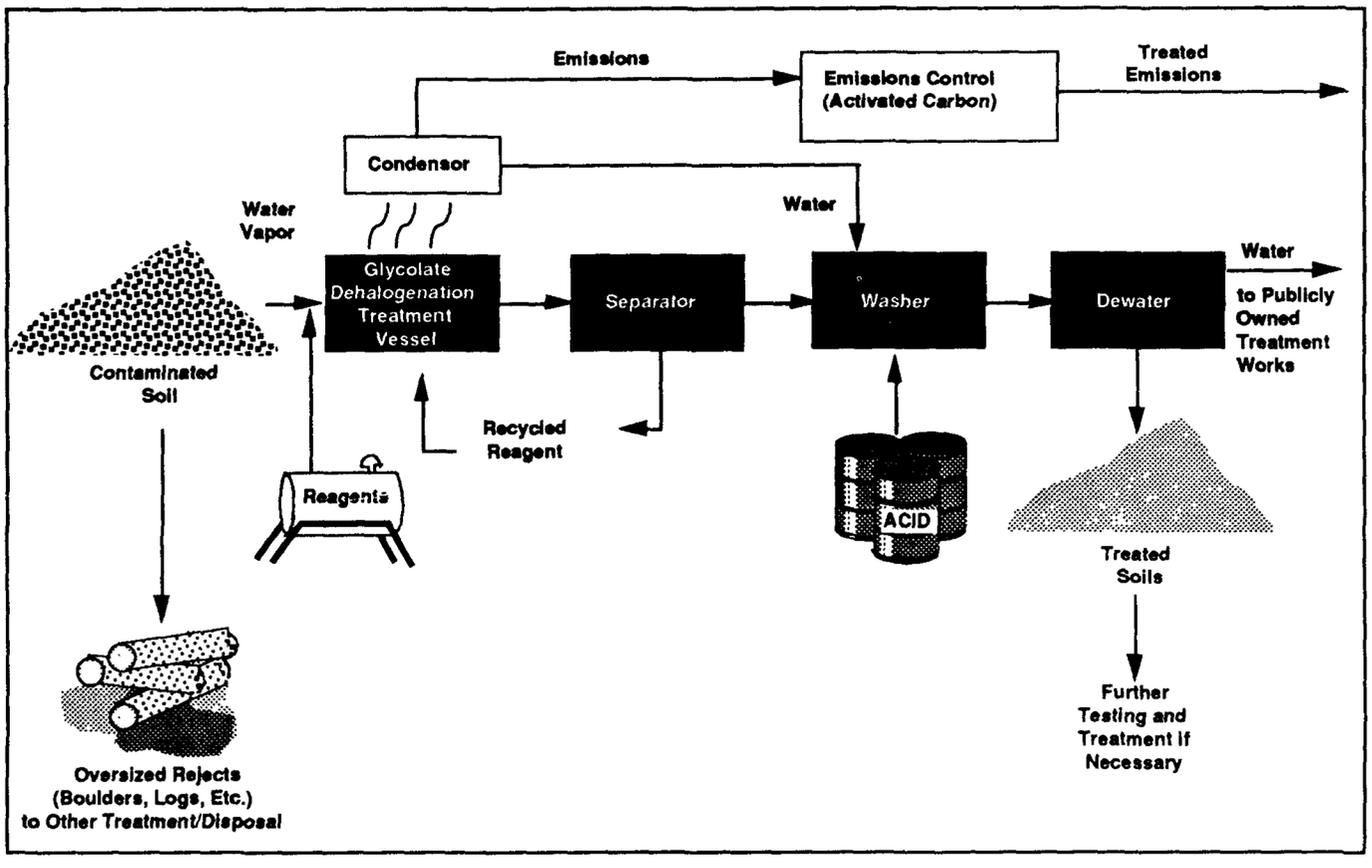


Figure 2
Glycolate Dehalogenation Process Flow



Why Consider Glycolate Dehalogenation?

Dehalogenation has proven to be effective in removing halogens from hazardous halogenated organic compounds, such as dioxins, furans, PCBs and certain chlorinated pesticides, and therefore rendering them non-toxic. An advantage of this technology is that it is usually less expensive than incineration. It requires standard treatment vessel equipment to mix and heat the soils and reagents, and the energy requirements are moderate. In addition, the treatment time required is short, and operation and maintenance costs are relatively low. The technology can be brought to the site, allowing hazardous wastes to be excavated and treated onsite.

Glycolate dehalogenation reactors have been successfully applied to sites containing PCB-contaminated waste oil. One such full-scale treatment vessel has a single batch capacity of 80 cubic yards and can treat 160 to 200 cubic yards of waste per day. Presently, significant advances are being made to further improve this technology. These advances will shorten the reaction times, reduce the energy required, and make the process more cost effective.

What Contaminants Can It Treat?

This technology is most successful in treating contaminants that have acquired cancer-causing or toxic properties as a result of having chlorine in their chemical structure. Such contaminants include dioxins, furans, PCBs, and some pesticides.

What is Chemical Treatment?

Chemical treatment is the process of changing the structure of a hazardous material either by adding, deleting, or rearranging smaller chemical components of the material. The purpose of chemical treatment is to reduce the hazardous characteristics of chemically contaminated material. This structural change (i.e., add, delete, rearrange) is accomplished through the action of chemical reagents. One specific type of chemical reagent will not act on all types of hazardous waste. It is the chemical composition of the hazardous material that determines the reagent to be used. This matching of reagent with the type of contaminant must be precise if chemical treatment is to be effective.

Will Dehalogenation Work At Every Site?

Glycolate dehalogenation is limited as a treatment method to halogenated compounds. It is not effective in situations where the contamination is highly concentrated, such as pure waste oils. Other characteristics of the contaminated material that interfere with its effectiveness are high water content, acidity, high natural organic content of the soil, and/or the presence of other alkaline materials similar to the reagents, such as aluminum and other metals. The proven effectiveness of the technology for a particular site or waste, as shown in Table 1, does not guarantee that it will be effective at all sites. Finally, the end products of the dehalogenation process may require further treatment to eliminate the by-products still left in the soil and water.

Where Is Dehalogenation Being Selected?

Table 1 at right lists some examples of Superfund sites where glycolate dehalogenation has been selected as a treatment method. There are other types of dehalogenation processes being considered and tested as well. Additionally, there are treatment technologies that enhance the effectiveness of dehalogenation.

Table 1
Site Locations Where Glycolate Dehalogenation Has Been Selected*

Site Name	Location	Type of Facility
Re-Solve	Massachusetts	Chemical reclamation
Palmetto Wood Preserving	South Carolina	Wood preserving
Sol Lynn/ Industrial Transformers	Texas	Transformer and solvent recycler

**All waste types and site conditions are not similar. Each site must be individually investigated and tested. Engineering and scientific judgment must be used to determine if a technology is appropriate for a site.*

For More Information

EPA prepared this fact sheet to provide basic information on glycolate dehalogenation. Additional technical reports are listed below. The documents containing a "PB" designation are available by contacting the National Technical Information Service (NTIS) at 1-800-336-4700. Mail orders can be sent to:

National Technical Information Service
Springfield, VA 22161

Other documents may be obtained by contacting:

Center for Environmental Research Information
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7562

There may be a charge for these documents.

- **Catalytic Dehydrohalogenation: A Chemical Destruction Method for Halogenated Organics, Project Summary, EPA/600/52-86/113.**
- **Comprehensive Report on the KPEG Process for Treating Chlorinated Wastes, PB90-163643.**
- **Innovative Technology: Glycolate Dehalogenation, EPA/9200.5-254FS; PB90-274226.**
- **Lauch, R. and others. "Evaluation of Treatment Technologies for Contaminated Soil and Debris"; Proceedings of the Third International Conference on New Frontiers for Hazardous Waste Management. Pittsburgh, PA, 1989, EPA/600/9-89/072.**
- **Technology Screening, Guide for Treatment of CERCLA Soils and Sludges, EPA/540/2-88/004.**

*U.S. Government Printing Office: 1992 — 648-080/60005