United States Environmental Protection Agency | Solid Waste and Emergency Response (5102G) | EPA 542-F-96-005 April 1996

EPA A Citizen's Guide to Thermal Desorption

Technology Innovation Office | Technology Fact Sheet

What is thermal desorption?

Thermal desorption is an innovative treatment technology that treats soils contaminated with hazardous wastes by heating soils to temperatures of 200-1,000°F so that contaminants with low boiling points will vaporize (turn into gas) and, consequently, separate from the soil. (The other soil contaminants, if any, are treated by other methods.) The vaporized contaminants are collected and treated, typically by an air emissions treatment system.

Thermal desorption is a different treatment process than incineration. Thermal desorption uses heat to physically separate the contaminants from the soil. The contaminants then require further treatment. Incineration uses heat to actually destroy the contaminants.

How does thermal desorption work?

Typical thermal desorption systems (Figure 1 on page 2) consist of three components: the pretreatment and material handling system, the desorption unit, and the post-treatment system for both the gas (vaporized contaminants) and the solid (remaining soil).

Pretreatment and Material Handling System

Pretreatment of contaminated material involves sifting it to remove large clods and foreign debris. If the contaminated material is very wet or has a high level of contaminant, it may need to be blended with sand or dried to make it a more uniform mass for treatment in the desorption unit.

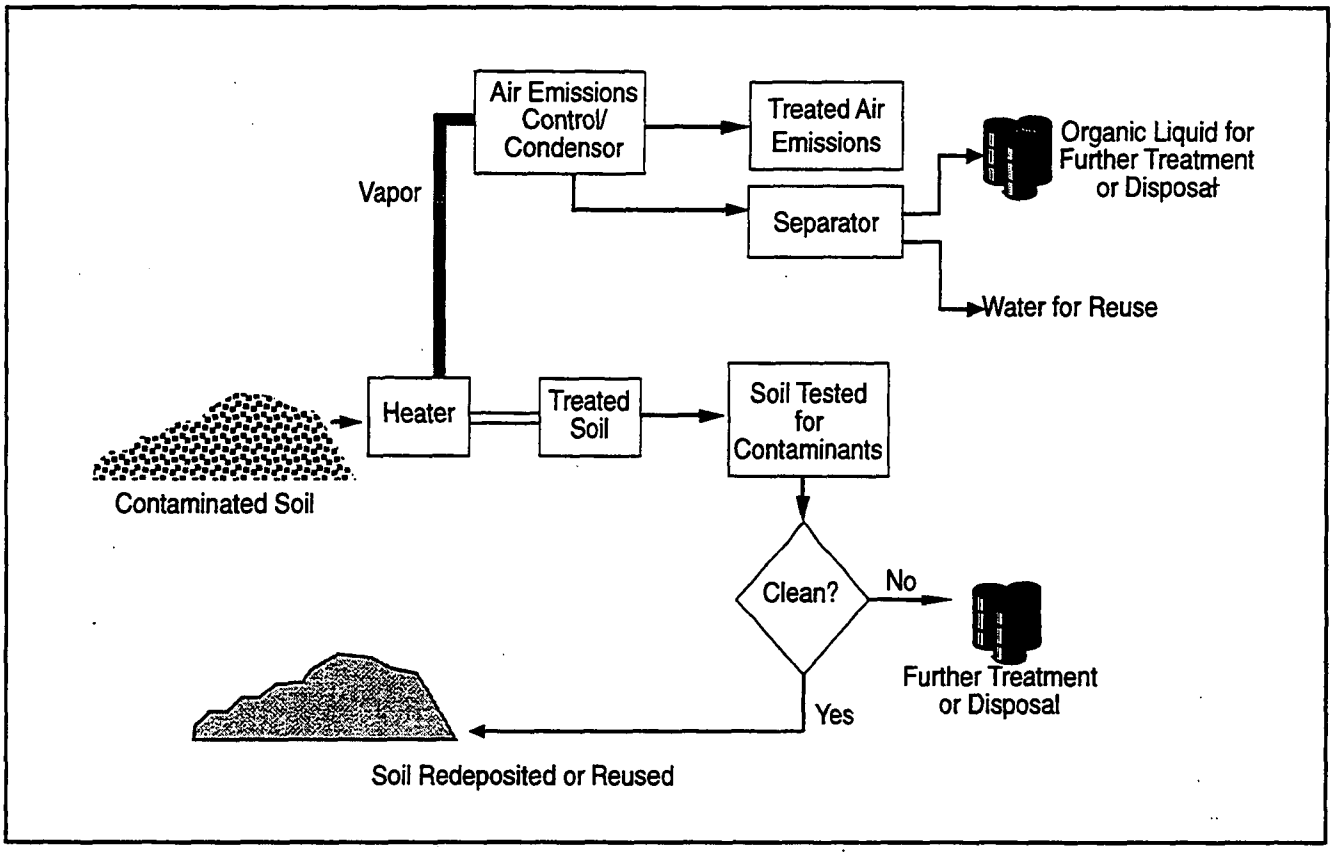
Desorption Unit

The function of the desorption unit is to heat the contaminated soil to a sufficient temperature for a sufficient period to dry it and vaporize the contaminants from the soil. A common design for the desorber unit is a *rotary desorber,* which consists of a rotating cylindrical metal drum. In a *direct-fired rotary desorber*, the material enters the rotating cylinder and is heated by direct contact with a flame or the hot gases coming off a flame. In an *indirect-fired rotary desorber*, the contaminated soil does not come into contact

A Quick Look at Thermal Desorption

- Heats soil at relatively low temperatures to vaporize contaminants and remove them.
- Is most effective at treating volatile organic compounds, semi-volatile organic compounds and other organic contaminants, such as polychlorinated biphenyls (PCBs), and polyaromatic hydrocarbons (PAHs) and pesticides.
- Is useful for separating organic contaminants from refining wastes, coal tar wastes, wood-treatment wastes and paint waste.

Figure 1
The Thermal Desorption Process



with a flame or combustion gases. Instead, the outside of the metal cylinder is heated and the hot metal indirectly heats the soil tumbling inside. As the waste is heated, the contaminants vaporize, and then become part of the gas stream of air and contaminated vapors flowing through the desorber towards the post-treatment system. An *inert*, or non-reactive gas, such as nitrogen, may be added to the gas stream to prevent the vaporized contaminants from catching fire in the desorption unit and to aid in vaporizing and removing the contaminants.

Post-treatment System

"Offgas" from the desorber is typically processed to remove particulates that remained in the gas stream after the desorption step. Vaporized contaminants in the offgas may be burned in an afterburner, collected on activated carbon, or recovered in condensation equipment. Depending on the contaminants and their concentrations, any or all of these methods may be used. All disposals must meet federal, state, and local standards.

Treated soil from the desorber is tested to measure how well the process removed the target contaminants. The performance of thermal desorption is typically measured by comparing the contaminant levels in treated soils with those of untreated soils. If the treated soil is non-hazardous, it is redeposited on-site or taken elsewhere to be used as backfill. If, however, the soil requires further treatment (for example, the soil contained contaminants that did not respond to this process), it may be treated with another technology or transported off-site for disposal.

Why consider thermal desorption?

Thermal desorption is effective at separating organics from refining wastes, coal tar wastes, waste from wood treatment, and paint wastes. It can separate solvents, pesticides, PCBs, dioxins and fuel oils from contaminated soil. The

equipment available is capable of treating up to 10 tons of contaminated soil per hour. Finally, the lower temperatures require less fuel than other treatment methods.

Will it work at every site?

Thermal desorption is not applicable to most metals, although mercury can be removed by the process. Other metals will either remain in the treated soil, in which case the soil must be retreated, or vaporize, in which case they may complicate the offgas treatment. The presence of metals and their fate must be determined before the soil is processed.

Thermal desorption is not equally efficient at treating all types of soil. If the soil is wet, water will vaporize along with the contaminants. Because of the additional substance (water) being vaporized, more fuel is required to vaporize all of the contaminants in the wet soil. Soils with high silt and clay content are also more difficult to treat with thermal desorption. When heated, silt and clay emit dust, which can disrupt the air emission equipment used to treat the vaporized contaminants. In addition, tightly packed soil often does not permit the heat to make contact with all of the contaminants. Therefore, it is difficult for them to vaporize. Finally, thermal desorption would not be a good choice for treating contaminants such as heavy metals, since they do not separate easily from the soil, and strong acids, since they can corrode the treatment equipment.

Where is thermal desorption being used?

Thermal desorption has been selected as a treatment method at numerous Superfund sites. For example, thermal desorption was used at the TH Agriculture & Nutrition Company site in Albany, Georgia. Thermal desorption was used at the site to treat 4,300 tons of oil contaminated with pesticides (dieldren, toxaphene, DDT, lindane). The system ran from July to October 1993. Thermal desorption met the cleanup goals, removing over 98% of the pesticides in the treated soil. Table 1 on page 4 lists some additional Superfund sites where thermal desorption has been used or selected for use.

What Is An Innovative Treatment Technology?

Treatment technologies are processes applied to hazardous waste or contaminated materials to permanently alter their condition through chemical, biological, or physical means. Treatment technologies are able to alter, by destroying or changing, contaminated materials so they are less hazardous or are no longer hazardous. This may be done by reducing the amount of contaminated material, by recovering or removing a component that gives the material its hazardous properties or by immobilizing the waste. *Innovative treatment technologies* are those 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.

Although thermal desorption is widely used, innovative variations are continually being developed. It is still difficult to predict with certainty the time and cost to clean a site using thermal desorption. For these reasons, it retains its "innovative" label as EPA continues to track its performance.

Table 1

Examples of Superfund Sites Using Thermal Desorption (all projects completed)*

Name of Site	Type of Facility	Contaminants
Re-solve, MA	Chemical reclamation	Volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs)
Metaltec/Aerosystems, NJ	Metal manufacturing	VOCs
Reich Farms, NJ	Chemical drum storage/disposal	VOCs, semi-volatile organic compounds (SVOCs)
American Thermostat, NJ	Thermostat manufacturing	VOCs
U.S.A. Letterkenney SE Area, PA	Munitions manufacturing/storage	VOCs
Wamchem, SC	Dye manufacturing	Benzene, toluene, ethylbenzene & xylene (BTEX), VOCs, SVOCs
Jacksonville NAS, FL	Fire training site	Polyaromatic hydrocarbons (PAHs)
Outboard Marine/Waukegan Harbor, IL	Marine products manufacturing	PCBs
Pristine, OH	Industrial waste treatment facility	BTEX, pesticides, herbicides, VOCs
Sand Creek Industrial, CO	Pesticide manufacturing	Pesticides, herbicides

For a listing of Superfund sites at which innovative treatment technologies have been used or selected for use, contact NCEPI at the address in the box below for a copy of the document entitled ***Innovative Treatment Technologies: Annual Status Report (7th Ed.)*, EPA 542-R-95-008.** Additional information about the sites listed in the Annual Status Report is available in database format. The database can be downloaded free of charge from EPA's Cleanup Information bulletin board (CLU-IN). Call CLU-IN at 301-589-8366 (modem). CLU-IN's help line is 301-589-8368. The database also is available for purchase on diskettes. Contact NCEPI for details.

* *Not all waste types and site conditions are comparable. 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

The publications listed below can be ordered free of charge by calling NCEPI at 513-489-8190 or faxing your request to 513-489-8695. If NCEPI is out of stock of a document, you may be directed to other sources. You may write to NCEPI at:

National Center for Environmental Publications and Information (NCEPI)
P.O. Box 42419
Cincinnati, OH 45242

- *Selected Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation: A Bibliography of EPA Resources*, EPA 542-B-95-001. **A bibliography of EPA publications about innovative treatment technologies.**
- *Physical/Chemical Treatment Technology Resource Guide*, September 1994, EPA 542-B-94-008. **A listing of publications and other sources of information about thermal desorption and other treatment technologies.**
- *Engineering Bulletin, Thermal Desorption,* February 1994, EPA 540-S-94-501.
- *Abstracts of Remediation Case Studies,* March 1995, EPA 542-R-95-001.
- *WASTECH® Monograph on Thermal Desorption,* ISBN #1-883767-06-7. Available for $49.95 from the American Academy of Environmental Engineers, 130 Holiday Court, Annapolis, MD 21401. Telephone 410-266-3311.