36 867 PDF

CONTAMINANTS AND REMEDIAL OPTIONS AT PESTICIDES SITES- A TECHNICAL RESOURCE DOCUMENT

Richard N. Koustas
USEPA Edison Facility
2890 Woodbridge Avenue
Edison, NJ 08837
Phone: 908-906-6898

INTRODUCTION:

Pesticide contamination includes a wide variety of compounds resulting from manufacturing, improper storage, handling, disposal, and/or agricultural processes. Remediation of pesticide-contaminated soils can be a complicated process, as most pesticides are mixtures of different compounds rather than pure pesticide. The remedial manager is faced with the task of selecting remedial options that will meet established cleanup levels. There are three principal options for dealing with pesticide contamination: containment/immobilization, destruction, and separation/concentration. This paper is condensed from the technical resource document (TRD) "Contaminants and Remedial Options at Pesticide Sites" and provides a brief summary on treatment technologies that are available or those being developed for pesticide contamination. Technologies that have not produced performance data are not included nor are water treatment technologies. This paper focuses on potential remediation techniques of soils.

CHARACTERISTICS OF PESTICIDES

Pesticides, as defined by the U.S. Federal Environmental Pesticide Control Act, are "...any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insect, rodent, nematode, fungus, weed or any other form of terrestrial or aquatic plant, animal life, or virus, bacteria, or other microorganism which the Administrator declares a pest". Pesticides include insecticides, fungicides, herbicides, acaricides, nematocides, and rodenticides as well as any substance or mixture of substances intended for use a plant regulator, defoliant, or desiccant. Pesticides do not include such substances as fertilizers or veterinary medicines. Pesticide wastes are generally complex chemical mixtures and not pure pesticides. These mixtures can include solvents, carriers and other components that will have a direct effect on toxicity, mobility, transport, and treatment.

Several classification criteria are utilized when grouping pesticides. Conventional classification methods are based on the applicability of a substance or product to the type of pest control desired. In addition, the EPA has its own classifications under the Resource Conservation and Recovery Act (RCRA) and Superfund. For the purpose of treatment, pesticides may be classified based on three characteristics: water solubility, contains metals or contains halogen. Therefore, TRD categorizes pesticides into four waste groups based on data needs for available treatment technologies:

WG01 - Inorganic pesticides
WG02 - Halogenated water insoluble organics
WG03 - Halogenated sparingly water soluble organics and organo-linked compounds
WG04 - Non-halogenated organics and organo-linked compounds.

The TRD provides details of the four pesticide waste groups and gives examples of commonly found pesticides. These groups are subdivided further to show the chemical class or family each pesticide belongs to according to their molecular structure or key functional group. Applicable treatment technologies for each waste group are also provided. References to pesticides and pesticide wastes in this document use the above waste group categories.

Most pesticides are adsorbed easily on soils because of their molecular weight. In fact, adsorption of pesticides on the soil surface is a dominant factor that affects the extent of the site contamination. As a rule, when applied properly, pesticides migrate slowly. Concentrated pesticide from a spill or leak can move more quickly into the subsurface, especially if the pesticide is an aqueous phase or under the influence of percolating water. Mechanisms of pesticide fate and transport that affect the extent of site contamination include: adsorption, biodegradation, volatilization, downward and lateral migration, and photolysis.

Selecting a remedial strategy includes considering the individual contaminant's toxicity, persistence, migration pathways, and rate of transport from a site. The wide range of physical and chemical properties of pesticides also influences the selection of an appropriate remedial technology or combination of technologies (known as a treatment train). It is important to gain information specific to the pesticide(s) present in order to effectively identify the treatment technology(ies) that is most applicable and cost effective.

The following sections present an overview of treatment technologies that have been used to treat, destroy, or remove pesticides from soil contaminated with pesticides. The technologies discussed are at various stages of development and application and are separated into immobilization, destruction and separation/concentration technologies.

IMMOBILIZATION OPTIONS

Immobilization technologies minimize or prevent the migration of the contaminant by utilizing physical barriers to inhibit the flow of groundwater through contaminated soil. The use of chemical reactions and/or physical interactions may also be employed to retain or stabilize the contaminant to prevent its migration into the surrounding environment. Immobilization techniques limit the mobility of the pesticides and provide no detoxification or volume reduction. These technologies include containment, stabilization/solidification (S/S) and in-situ vitrification (even though in-situ vitrification is considered a thermal process, its primary goal is to immobilize the contaminant).

Containment of contaminant plumes via capping or vertical barriers is often a component of an overall remediation plan. These technologies are used with groundwater extraction and treatment. In S/S technologies, a chemical reagent is mixed with the contaminant to physically bind or chemically react to reduce its mobility or restrict contact with a mobile phase. Cement based processes are more suitable for inorganic pesticides (WG01) and are often effective in reducing the mobility or leachability of metals.

In-situ vitrification (ISV) is used to melt contaminated soils and convert them into a glass-like material of very high stability and chemical inertness. Typically, an electric current is used to generate temperatures of up to approximately 2,000°C in order to fuse the soil. Gases containing vaporized water and organic substances are collected at the surface for treatment. ISV is commercially available and can be used to destroy or capture organic pesticides in waste groups WG02, WG03, and WG04 as well as to immobilize inorganic pesticides (WG01) within the melt.

DESTRUCTION TECHNOLOGIES

Destruction technologies are used to reduce or eliminate toxicity and often decrease volume and/or mobility. Contaminated soils that are treated using destruction technologies regularly require materials handling steps such as excavation, dewatering, conveying, and screening prior to treatment. Additionally, large volumes of soil may require separation or concentration of the contaminants in order to reduce the total volume to be treated. Destruction technologies include thermal, chemical, and biological treatments.

Thermal destruction technologies include incineration and ultra-high temperature processes (e.g., plasma-arc). Incineration is commercially available that utilizes thermal energy (heat) in the presence of oxygen to combust the pesticides and other organic contaminants in soils. Incineration can be used to remediate soils contaminated with organic pesticides (WG02, WG03, and WG04). Incineration of inorganic pesticides from WG01 may result in volatilization of metals into off gases or concentration of metals in the ash.

Chemical destruction technologies that are potentially applicable for remediating pesticide-contaminated soils include chemical oxidation, dehalogenation, hydro processing/heteroatom removal, and hydrolysis/neutralization. These technologies use chemical reactions to reduce or eliminate the contamination in soil containing pesticides.

Chemical oxidation is the most well known of the chemical destruction technologies. Although its use in environmental remediaton has been very limited, it as been used successfully by the chemical processing industry. This treatment may be used to treat organic pesticides (WG02, WG03, and WG04). The possible formation of partially oxidized compounds due to incomplete oxidation should be considered. Variants of oxidation technology may employ air, oxygen or other oxidizing agents.

Dehalogenation removes the halogen atoms from halogenated organic compounds, resulting in significantly reduced toxicity. This technology is applicable to halogenated organic pesticides in waste groups WG02 and WG03. This technology has been demonstrated at the bench and pilot-scale levels as effective on pesticide-contaminated soils.

Hydrolysis/neutralization is a chemical treatment process that results in the destruction of the contaminant under acidic or alkaline conditions. The products of this reaction generally consist of smaller and less toxic molecules: however, an incomplete chemical reaction may produce toxic by-products. This technology can be used to detoxify waste groups WG03 and WG04 and has been demonstrated at the bench and pilot-scale levels.

Bioremediation is typically applicable for treatment of media contaminated with low concentrations of organic pesticides (WG01, WG02, WG03). Oxygen and nutrients are often supplied to the soil to allow microorganisms to metabolize the organic compounds present. The presence of inorganic pesticides (WG01) may inhibit the microbiological degradation process. This technology is available at full-scale.

SEPARATION/CONCENTRATION OPTIONS

Separation/concentration options utilize physical or chemical processes to concentrate contaminants by removing them from the media in which they are contained. These technologies do not reduce the toxicity of the contaminants or inhibit mobility. Rather, they reduce the volume of material requiring treatment by collecting the contaminents in a concentrated form or transferring them to another medium that is easier to handle or treat. These technologies include radio frequency (RF) heating, soil washing, thermal desorption, and solvent extraction.

Radio frequency heating utilizes electromagnetic energy to heat soil to temperatures as high as 300°C. Large volumes of contaminated soil can be heated, with resultant organic contaminant removal via steam stripping, boiling, and vaporization. This technique can be used to remediate soils contaminated with pesticides that typically volatilize between 80°C and 300°C, such as halogenated volatile alphatics in waste group WG03. Other pesticides that have been removed include WG02 pesticides such as aldrin, dieldrin, endrin, and isodrin. This technology is currently in the pilot and field-scale stage and has been demonstrated at the Rocky Mountain Arsenal.

Soil washing is used to remove contaminants from soils by dissolving or suspending them in a wash liquid. Fine particles such as clay and silt containing adsorbed insoluble contaminants also may be separated from the coarser soil fractions using soil washing. The wash liquid is then separated using conventional water treatment methods, while the cleaned coarse fraction that composes the bulk of the soil volume is backfilled or reclaimed. Soil washing can be used to treat soils contaminated with pesticides from all four waste groups (WG01, WG02, WG03, WG04). This technology is available for full-scale use and has been used to remove dieldrin in a bench-scale study at the FMC Fresno Superfund site.

Thermal desorption is used to remove volatile and semivolatile organic chemicals from contaminated soils by increasing the soil temperature. Depending on the vapor pressure of the contaminants in the soil, temperatures are raised to 200^{o}-$1000^{o}F$ to desorb organic compounds. The compounds are then transferred to the vapor phase and are either destroyed, condensed and reclaimed, or treated with carbon. This technology is commercially available and can be used to remove pesticides in waste groups WG02, WG03, and WG04 from contaminated soil.

Solvent extraction uses organic solvents to remove organic compounds from contaminated soils and reduces the contaminant volume by transferring the contaminant from the soil and concentrating it in an extract phase. Solvent extraction treatment is applicable to soils contaminated with organic pesticides (waste groups WG02, WG03, WG04). Solvent extraction is commercially available.

REFERENCE:

USEPA Contaminants and Remedial Options for Pesticides-Contaminated Sites, EPA Number - Not yet available.

FOR MORE INFORMATION:

Richard N. Koustas, U.S. EPA, Risk Reduction Engineering Laboratory,
2890 Woodbridge Avenue, (MS 106), Edison, New Jersey 08837
Phone: (908) 906-6898, Fax, (908) 906-6990

CONTAMINANTS AND REMEDIAL OPTIONS AT SELECTED METALS CONTAMINATED SITES - A TECHNICAL RESOURCE DOCUMENT

Michael D. Royer
Technical Support Branch/RREL
U.S. EPA
Bldg.# 10 (MS-104)
2890 Woodbridge Avenue
Edison, NJ 08837-3679
Phone: 908-321-6633

Lawrence A. Smith
Battelle
505 King Avenue
Columbus, OH 43201-2693
Phone: 614-424-3169

INTRODUCTION

A technical resource document, Contaminants and Remedial Options at Selected Metals-Contaminated Sites, has been produced to assist site remediation managers to select treatment technologies for contaminated soils, sludges, sediments, and waste deposits at sites where inorganic arsenic (As), cadmium (Cd), chromium (Cr), mercury (Hg), or lead (Pb) are the primary contaminants of concern. These five metals have been addressed because of their toxicity, industrial use, and frequency of occurrence at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites and in Resource Conservation and Recovery Act (RCRA) hazardous wastes. This document should prove useful to all remediation managers, whether their efforts fall under federal, state, or private authority, and whether they are applying standards from RCRA, CERCLA, and/or state programs.

METHODOLOGY

A diligent effort was made (subject to the key limitations noted below), to identify, collect, analyze, and organize information, data, and pertinent references that a remediation manager would find useful for identifying and selecting remedial alternatives for soils, sediments, sludges, and waste deposits in which the principal contaminants are As, Cd, Cr, Hg, or Pb and selected inorganic compounds of these metals. The types of information collected to support preparation of this document include the following.

- Background information on As, Cd, Cr, Hg, Pb, and associated inorganic compounds regarding mineral origins, processing, uses, common matrices, chemical forms, behavior, transport, fate, and effects.

- Existing remediation performance data, listed below, in rough order of desirability: (a) full-scale remediation of As, Cd, Cr, Hg, and Pb contaminated sites; (b) technology demonstrations on As, Cd, Cr, Hg, or Pb contaminated sites under the EPA Superfund Innovative Technology Evaluation Program; (c) RCRA As, Cd, Cr, Hg, and Pb bearing hazardous wastes for which Best Demonstrated Available Technologies have been established; (d) waste applicability/capacity information for treatment technologies as described in technology guides and the EPA Vendors' Inventory of Superfund Innovative