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CURRENT RESEARCH ON THE DISPOSAL OF HAZARDOUS WASTES

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Summary

The Solid and Hazardous Waste Research Laboratory is one of six laboratories in the Environmental Protection Agency (EPA), National Environmental Research Center at Cincinnati, Ohio The laboratory is responsible for research into new and improved systems of solid and hazardous waste management, development of technology, determination of environmental effects, and collection of data necessary for the establishment of processing and disposal guidelines In the past, the laboratory concentrated on problems associated with municipal solid waste, but recently the emphasis has shifted, and present efforts are directed primarily toward the problem of industrial hazardous waste disposal on land Under the solid waste program, investigations were initiated on the migration of municipal landfill leachate and leachate containment with synthetic liners These studies have been underway for more than a year, but they will not be discussed here because of the present emphasis on industrial hazardous waste problems Although none of our research projects is concerned specifically with the disposal of residues and sorbants generated during cleanup of hazardous material spills, much of the forthcoming information will be applicable to spill-cleanup problems The extramural projects and program areas described here involve many activities that could be useful in spill problems

Migration of hazardous materials

The first program area is the migration of hazardous materials from land disposal sites Knowledge of the rates and extent of movement of hazardous materials in soils is of fundamental importance in formulating hazardous waste management regulations and recommendations for safe land disposal sites and procedures. The extramural grant and contract activities that will supply this information can be grouped into three broad categories. (1) review and synthesis of available information, (2) studies under controlled conditions using actual wastes, and (3) field testing of conclusions drawn from the first two activities

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Review and synthesis

The review and synthesis of available information will provide a basis for tentative disposal recommendations and guidance of the research under controlled conditions. During the current fiscal year, three publications will be issued (a) a partially annotated bibliography on migration and transformation in soil of selected organic and inorganic hazardous material, (b) a report on the present knowledge of migration of inorganic hazardous materials in the soil, and (c) a similar report on the migration of pesticides. The conclusions drawn from these three publications should, of course, be compared with the results from the ongoing controlled-condition laboratory studies and from the field studies currently planned or underway.

Controlled laboratory studies

Solid and semisolid wastes are complex mixtures, and the leachates from these wastes commonly contain high concentrations of hazardous materials and other soluble substances that influence adsorption on soil colloids and other migration-related soil processes. The controlled-condition studies use industrial wastes to collect information that could not be obtained from the literature (which deals mainly with single compounds in dilute solution) or from the laboratory work with single compounds and simulated wastes. Basically, these studies consist of leaching the wastes to determine the types and amounts of hazardous materials released. Some of this leachate is then applied to several different types of soils, and migration rates are observed so that an "attenuation coefficient" can be constructed describing the type and degree of hazard associated with a particular combination of waste and soil. Work is underway on wastes from five industries mercury cell chlorine production, electroplating, nickel—cadmium battery production, inorganic pigments, and water-based paints. In the near future, the project will be expanded to include flue-gas desulfurization sludges and wastes from at least 25 other industries.

The controlled-condition laboratory studies will provide an estimate of migration rates and of the degree of hazard involved in land disposal of these wastes These estimates will be at least partially validated by field studies that are just being initiated. Running concurrently with the laboratory work, the field studies will examine the rate and extent of hazardous material migration from industrial disposal sites that receive some of the same wastes studied in the laboratory The objectives of the field studies are to check preliminary interpretations of the laboratory work, particularly the indication that disposal sites underlaid by fine-textured soils are suitable for certain types of wastes, and to point out gaps in knowledge and monitoring techniques that may require new studies or changes in ongoing laboratory studies The migration research is generally designed to support development of regulations and recommendations about the types of untreated wastes and unimproved sites that are suitable for land disposal

Stabilization studies

A substantial number of hazardous wastes will probably be identified as requiring some treatment before disposal, and only a limited number of disposal sites are expected to be usable without improvements Work has thus been initiated on methods of chemically stabilizing and encapsulating wastes to prevent leaching Also, a number of synthetic and admixed materials are being tested as potential liners for sites that are not naturally suitable for disposal of hazardous wastes. The chemical stabilization studies will use at least four of the same industrial wastes used in the migration study to serve as a check on some of the analytical procedures and to define the disposal options for these wastes.

Chemical stabilization

The chemical stabilization project is a coordinated laboratory and field study designed to evaluate the leachability and durability of industrial wastes that have been chemically stabilized by presently available commercial methods. The laboratory phase of the leachability study will include the use of deionized water and an acid solution to leach raw and stabilized wastes both in small batches and in larger columns to simulate *in situ* conditions Solubility rates for selected hazardous substances such as cyanides, copper, arsenic, fluoride, nickel, cadmium, and mercury will be determined from raw samples and samples that have been stabilized by five different processes. The durability testing of the stabilized wastes will include grain-size analysis, unconfined compression, and wet—dry, freeze—thaw, and other tests to provide an estimate of the physical integrity of the stabilized materials after disposal The laboratory study is designed to demonstrate the availability of chemical stabilization processes for different types of wastes and to define potential pollution problems, site utilization potential, and cost effectiveness

The field study will involve the testing of selected stabilization processes in a simulated municipal landfill and in unimproved land disposal sites under actual environmental conditions Two simulated landfill cells, approximately 6 ft in diameter and 10 ft high, will be packed with a mixture of municipal refuse and stabilized hazardous materials Several field plots will be constructed with stabilized hazardous materials to duplicate current disposal practices Leachates from both the simulated landfill cells and the plots will be monitored to verify predictions based on the laboratory study

Encapsulation

The chemical stabilization processes, though considerably more expensive than unmodified disposal, are still relatively cheap and will be applicable to a wide range of high-volume wastes with moderate concentration and leachability Encapsulation, a much more expensive procedure, is being developed to handle low-volume wastes that cannot be satisfactorily stabilized and that present serious disposal problems because of their concentration, leachability, or toxicity

Basically, encapsulation is a two-stage process. The waste is first physically incorporated into a solid inner matrix to reduce the solubility and the surface area available for dissolution This solid matrix is then coated with an impervious encapsulation medium that waterproofs the inner matrix and protects it from external physical and chemical attack after disposal.

During fiscal year 1976, the encapsulation project is examining organic polymers as encapsulating materials. Polybutadiene resins with carboxyl groups are being tested as inner matrices, and polyvinyl chloride plastisols, polybutadiene-modified epoxides, and polyethylene resins treated with polybutadiene are being evaluated for use as the outer encapsulation medium The materials have been tested in bench-scale studies utilizing a granular, simulated hazardous waste, and promising results have been achieved Initial problems of incorporating the waste into the inner matrix and bonding the encapsulation material to the matrix have been overcome Selective heavy metal diffusion through the encapsulation material has been observed during leaching tests, but the long-term significance of this phenomenon relative to the total amount of material in the waste has not yet been evaluated Planned activities include encapsulation of actual industrial wastes and testing of the encapsulated waste to determine stability under varied environmental stresses.

Liner studies

Chemical stabilization and physical encapsulation are potential methods for safely disposing of hazardous wastes at landfill sites with satisfactory or marginal soils and hydrology. Unsatisfactory sites, however, must first be modified by lining them with natural clay soils, synthetic materials, or a combination of the two The field and laboratory migration studies of hazardous materials will provide data on the types and thicknesses of natural soils required to restrict water flow and pollutant migration from disposal sites The liner studies scheduled to begin later this year will produce similar data for some synthetic materials.

The liner study involves the testing of synthetic materials exposed to hazardous wastes. The tests will include hardening, tear strength, permeability, swell, and other tests to characterize the physical and chemical reactions of the liner materials to the waste Liner materials to be studied include synthetic membranes such as polyvinyl chloride, polypropylene, and butyl rubber, and admixed materials such as asphaltic concrete, bituminous sealcoat, and soil cement The wastes used in the study could include organic and inorganic residues from plating and metal finishing, pesticide manufacture, battery manufacturing, and pharmaceutical production

The study will be conducted over a 30-month period. The liner materials will be evaluated initially and again after 12- and 24-month exposure The results are expected to (1) demonstrate the durability, performance, and cost-effectiveness of utilizing synthetic materials to prevent pollutant migration, and (2) provide design data sufficient to predict the life of the material and the amount of attenuation, if any, that will occur with the use of a synthetic liner

Pesticides

Pesticides, which present a special disposal problem because of both the quantity and concentration, cannot generally be handled by any of the methods described Incineration of organic pesticides can be a convenient method of disposal, provided the incinerator operating parameters (particularly the temperature and the retention time) are known The Solid and Hazardous Waste Research Laboratory is sponsoring research on the safe and efficient disposal of cancelled, excess, or banned pesticides A bench-scale research effort is using thermogravimetric techniques to establish time/temperature requirements for 34 different pesticides After incorporating safety factors and scale-up factors, tentative operating parameters will be established for the safe incineration of each. Using these guidelines, another study employing a pilot-scale incinerator (100 lb./h) will operate on a large scale using required EPA monitoring equipment to determine if the laboratory data can effectively be scaled-up for all materials. The results of these studies should permit establishment of minimum thermal conditions necessary for degradation of certain organic pesticides.

Conclusion

The laboratory-sponsored project areas and studies described here have potential application to the problems encountered during cleanup of hazardous materials spills. More information about a specific study or project area is available from Robert L Stenburg, Solid and Hazardous Waste Research Laboratory, U.S. Environmental Protection Agency, National Environmental Research Center, Cincinnati, Ohio. 45268