

**Department of Energy**

Richland Operations Office
P.O. Box 550
Richland, Washington 99352

0003524

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Mr. Roger F. Stanley
Hanford Project Manager
State of Washington
Department of Ecology
Olympia, Washington 98504-8711



Dear Mr. Stanley:

TREATABILITY TEST EXCLUSION NOTIFICATION

In response to your letter of December 21, 1988, we are submitting the information requested as an attachment to this letter.

Since we currently have a number of treatability tests on hold due to your supplemental request, we would request your cooperation by responding with your comments/concurrence verbally to Ms. M. J. Anthony (DOE-RL) on (509) 376-8375 as soon as possible.

If you have any questions regarding this letter, please contact Ms. M. J. Anthony.

Sincerely,

E A Bracken

E. A. Bracken, Acting Director
Environmental Restoration Division
Richland Operations Office

ERD:MJA

T D Chikalla

T. D. Chikalla, Director
Facilities & Operations
Pacific Northwest Laboratory

R E Lerch

R. E. Lerch, Manager
Environmental Division
Westinghouse Hanford Company

Attachment

cc w/att:
T. D. Chikalla, PNL
P. T. Day, EPA
T. Eaton, Ecology
R. E. Lerch, WHC
W. Pierre, EPA

ENCLOSURE

TREATMENT TEST EXCLUSION NOTIFICATION

The following information is provided in response to a December 21, 1988, letter from R. F. Stanley (WDOE) to R. D. Izatt (DOE-RL), R. E. Lerch (WHC), and T. D. Chikalla (PNL). Each of the five questions asked by WDOE is restated with a response provided below.

1. DESCRIPTION OF TREATMENT PROCESS AND WASTE(S) INVOLVED

Waste(s) Involved in Treatability Tests

The exact nature of the types of wastes to be used in the treatability tests are not known. Anticipated wastes include organic and inorganic materials; dangerous, extremely hazardous, and mixed wastes; materials from old spill sites, seepage pits, buried waste, contaminated soils and groundwater; and wastes from active and inactive RCRA sites.

Microbiological Treatment of Soils, Sludges, Effluents, and Groundwater

Biological waste treatment technologies are processes that use microorganisms, such as bacteria and fungi, to facilitate degradation of waste materials. In most cases, the waste material is used by the microorganisms in catabolic (external to the cell) chemical reactions. The biological waste treatment processes produce low-hazard materials, such as water, carbon dioxide, and excess microorganisms (biomass). The processes generally require water, but also may be used with soils and sludges.

Biological waste treatment studies may be conducted in above-ground facilities or in situ for contaminated soils. Above-ground studies would use equipment ranging in size from laboratory and bench-scale to full-scale units. Typical equipment would include a bioreactor or other container for the waste material and microorganisms, a device (such as a filter) to separate excess biomass and product, and associated monitoring and process control equipment.

In Situ Vitrification

In situ vitrification (ISV) is a thermal treatment process that converts contaminated soil and sludges into a glass and crystalline product. An electrical current is passed among an array of four electrodes imbedded in the contaminated soil or sludge, melting and glassifying it. The process continues outward and downward until the appropriate vitrification depth is obtained. Radioactive mixed waste and dangerous waste constituents are stabilized in the glass and crystalline product. Organic contaminants are destroyed by pyrolysis, and the pyrolysis products oxidize as they migrate to the surface.

Waste Vitrification

Waste vitrification utilizes a procedure similar to ISV except that the waste to be vitrified is not treated in situ. Instead, the waste is brought to the vitrification equipment location and is then turned into a glass and crystalline product. The vitrification is accomplished in a ceramic-lined vessel, and hazardous wastes are continuously fed to the vessel. The resulting glass is poured into a receiving container.

In Situ Heating

This process involves electrical energy discharge. Heat is applied to the soil resulting in the treatment and removal of volatile or semivolatile chemically hazardous wastes, e.g., carbon tetrachloride from the soil column. The process works by applying high voltages (up to 1000 kV) through an array of electrodes. Heat is dissipated among electrodes, thereby improving removal efficiencies of conventional processes such as venting, air stripping, or vacuum induction.

Metal Melting

Metal melting systems can be used for volume reduction and immobilization of contaminated equipment, piping, etc., and may reduce the cost of waste handling. The high temperatures required for melting the materials serve to destroy hazardous organic species as well. The metal melting systems being considered include both plasma and induction-heated furnaces.

Microwave Heating and Treatment

Microwave heating and treatment delivers thermal energy to waste materials from a microwave-generating device for the purposes of drying, solidifying and/or melting wastes. Microwave heating may be used for several purposes, i.e., pretreating (dry and solidify) or treating (heat to melt or destroy) wastes, such as underground tank wastes, or contaminated soils.

In-Can Melting of Soils, Wastes, and Slurries

This procedure can be used to form waste glasses concentrated in waste components that normally inhibit their performance in a joule-heated glass melter. The glass-melting process is conducted directly within the receiving container. Heat is applied by electrical resistance or induction heating.

Thermal Treatment of Slurries

Liquid waste materials are passed through a special, heated chamber known as a calciner. Water and organic solvents are evaporated and passed through an afterburner, if required. The remaining inorganic hazardous materials are converted to a stable oxide form that is well suited for direct disposal or additional treatment by melting, or other organic-binding techniques.

Plasma Arc Pyrolysis

Plasma arc pyrolysis is the use of electrically ionized, high-temperature gas for the destruction of solid or liquid material. This process allows a wider range of gases to be used than for regular heating applications because the gas does not have to be flammable. The high temperatures produced by a plasma torch, up to 10,000°F, are capable of completely destroying or decomposing to elements many materials that cannot be incinerated economically. It has the added benefit that the off-gas can be collected and recycled. Plasma arc torches are adaptable to mobile facilities and continuous feed applications.

Gamma-Induced Oxidation

Gamma irradiation, which is produced by individual or serial cesium or cobalt capsules, can be used to oxidize many organics. Doses in the range of 100 rads have been used to partially decompose some common organics. Extremely intractable compounds such as PCBs can be detoxified and, in some cases, decomposed to carbon dioxide and methane by doses in the 1 to 5 Mrad range. Due to the penetrating power of gamma irradiation relative to other types of irradiation, it has a wide range of applications, including those performed on slurries, solids, and liquids. The use of oxidants such as ozone or hydrogen peroxide accelerates the decomposition of organics. This technique is amenable to batch liquid applications, such as contaminated liquids using agitated containers, and it is also adaptable to mobile facilities or continuous feed applications.

Grout

Hydraulic binders, such as Portland cement, various clays, and specific additives, can be used to encapsulate and stabilize a wide range of metals, inorganics, and organics. Endogenous water or added liquid is used in conjunction with a specifically tailored or general matrix of materials to produce a stabilized product that is environmentally stable and has great physical strength. Specific applications can be made to petroleum refinery sludge, heavy metals waste, and hazardous chemical wastes.

Distillation

The separation of materials with different boiling points by using common laboratory distillation can be used to facilitate the treatment of many chemical hazardous waste streams. Many times the treatment for a complex waste stream is considerably more difficult than treating the individual components. Distillation can be used for this purpose and can also be used to separate solids from liquids.

One type of distillation treatability test will be used to recover acids and metals from spent acid solutions. These types of streams are generated from metal-finishing operations. The solutions will be mixtures of $\text{HNO}_3/\text{H}_2\text{SO}_4$ or $\text{HF}/\text{HNO}_3/\text{H}_2\text{SO}_4$. The metals in these solutions may include

Cu, Zr, U or other radionuclides. In the distillation process, the metal-bearing mixed acid is fed to a flash evaporation unit where the HNO_3 vaporizes to the overhead stream. The H_2SO_4 and metals remain in the liquid bottom stream, which will be either crystallized or neutralized to recover the metal salt. The vaporized HNO_3 will flow to a rectification column, where it will concentrate in the bottoms stream to a predetermined concentration. The overhead stream from this rectification step is water that can either be recycled as a rinse in actual practice or discharged.

Electropolishing

Electropolishing is an anodic electrochemical dissolution method for the removal of hazardous chemicals from metallic surfaces. It is applicable to both inorganic and organic contaminants, as long as they do not form an electrically insulating layer. This technology has an added use as a pre-exposure treatment. Electropolishing removes microscopic imperfections on metallic surfaces, making binding of wastes to that surface much less likely.

Electrodissolution

Electrodissolution is similar to electropolishing except that, since it is not being used for the polishing of surfaces, a wider range of electrolytes can be used. It is mainly applicable to organic contaminants, and besides removing waste from surfaces, it actually destroys the contaminants by oxidation or reduction.

Electrochemically Enhanced Oxidation/Decontamination

Electrochemical oxidation is a process that can be used to destroy organics in an aqueous solution. The process takes place in liquids during electrolysis and does not require the vaporization of the organic material. A semipermeable membrane is inserted in an electrochemical cell to separate the anode and cathode. The organic, mixed with acid, is pumped into the anode or oxidizing part of the cell, and an acidic mixture without the organic is put in the cathode side. During electrolysis, hydrogen is produced at the cathode and the organic is decomposed to carbon dioxide and water at the anode.

Ion Exchange

An artificially prepared polymeric matrix with exposed charged groups (an ion-exchange resin) can be used to separate charged components from a complex mixture. Ion exchange can be carried out by: 1) passing the mixture through a column filled with an ion-exchange resin of opposite charge to the charge on the material to be separated or 2) mixing the resin with the material and filtering. Its main applicability is to aqueous solutions for the removal of small molecular or elemental ions such as metals, halides, sulfides, or acids with low molecular weight.

Waste Concentration, Dissolution, Precipitation, Filtration, Retrieval, Solvent Extraction

Many complex mixtures of materials can be separated by using different combinations of component's solubilities, different concentrations, solvents, reactions, or temperatures. An example is the precipitation of silver using sulfur salts. Many times, lowering the temperature is enough to make some components insoluble in a mixture so that they may be removed by filtration. Sometimes, components can be removed by extracting them with a solvent in which they are more soluble, i.e., removing soluble organics from water by extraction with a water-insoluble organic. The reverse process may also be used, i.e., making a component more soluble in a mixture by adding a solvent or additional component.

Solids Washing

Many times a hazardous material can be removed from a solid matrix by washing. If the solid is not too porous, the hazardous material is usually adsorbed on the surface and can be easily dissolved from the surface by using a solvent or heated aqueous solution. It can take many forms, including vapor or liquid washing, and is mainly applicable to soils contaminated with simple organic wastes.

Catalytic Destruction

Many organic hazardous wastes can be destroyed or converted to a less toxic or recyclable product by vaporizing the waste and then passing the vapor over a catalyst, e.g., the catalytic converter used on newer automobiles. The most important use is on aqueous organic mixtures that have traditionally been difficult to treat.

Sludge-to-Oil Conversion

Another in the group of thermocatalytic conversions is the sludge-to-oil reactor system. By using a form of catalytic destruction where the catalytically converted off-gas is collected, great energy savings can be realized through the generation of a grade 2 diesel fuel, a more concentrated solid fraction resulting in lower disposal cost, and the purification of an aqueous phase.

Supported Liquid Membranes

A supported liquid membrane (SLM) is a microporous, polymeric film containing an organic solution, which consist of a carrier and a diluent, in the pores. Both surfaces of the SLM are in contact with different aqueous solutions. One solution, in this case the groundwater, contains a dissolved, inorganic, chemical species that is to be separated from the remainder of the solution. This chemical species diffuses through the aqueous boundary layer to the aqueous-organic interface where chemical reaction with the carrier yields an organic soluble complex. The complex diffuses through the membrane to the interface between the organic solution

and the aqueous strip solution. At this interface, the carrier reacts reversibly with the chemical species, which then diffuses into the strip solution. Thus, the carrier is regenerated and diffuses back through the membrane to repeat the mechanism. Common configurations for the SLM systems are the flat sheet and the tube and shell designs.

Reverse Osmosis

Reverse osmosis is a membrane separation process that can reduce concentrations of dissolved organic and inorganic compounds and ions by 90% or more.

Reverse osmosis is based on the principle of osmosis, i.e., the spontaneous transport of water from a dilute solution to a more concentrated one, across a semipermeable membrane. Osmotic pressure is the pressure exerted by the fluid on the membrane when equilibrium is reached and no net flow across the membrane occurs. In a reverse osmosis system, water to be treated is passed through the membrane at a pressure greater than the osmotic pressure of the solution. Due to the pressure differential, the water, as permeate, is forced through the membrane, retaining the contaminants in a concentrated waste stream. The concentrated stream is generally 15 to 30 percent of the feed stream.

Electrodialysis

Electrodialysis is a membrane-separation process that can be used to remove ionic compounds from contaminated groundwaters. A typical electrodialysis cell consists of an anode and a cathode separated by an anion-permeable membrane near the anode and a cation-permeable membrane adjacent to the cathode. An electrical charge is applied across the cell, and as the water flows through the channel between the two membranes, the positively charged ions are drawn through the cation-permeable membrane to the cathode. Likewise the negatively charged ions are drawn to the anode. As a result there is a significant reduction in ionic compound concentrations in the intermediate channel containing the treated effluent. An electrodialysis system generally consists of many thin cells stacked in parallel. The resultant waste streams consist of the anion- and cation-concentrated streams and typically is approximately 10 percent of the influent stream. Generally these two streams are combined for disposal; however, they can be processed separately.

Lysimeters

Lysimeters are man-made, horizontally-oriented pipes or culverts used to monitor leachate generation, retardation coefficients, waste form durability, and transport properties of hazardous and mixed waste under environmental conditions. These pipes are fitted with various instruments, along with soils and various wastes. Measurements are made as leachates move downward through the pipes. Investigators look for natural treatment efficiencies of soils as precipitation mobilizes waste leachates. In some cases, man-made controls are simulated, such as engineered barriers

(e.g. clay caps) to additionally determine the barriers effectiveness to minimize contact between the waste and precipitation.

2. MAXIMUM WEIGHT OF EACH WASTE TO BE TREATED IN ANY ONE DAY

250 kg of "as received" waste for each laboratory building

3. MAXIMUM WEIGHT OF EACH WASTE TO BE STORED AT ONE TIME

1000 kg, which may include 500 kg of soil/water/debris contaminated with acutely hazardous waste or 1 kg of acutely hazardous waste per laboratory

4. MAXIMUM LENGTH OF TIME SAMPLES WILL REMAIN IN THE LAB BEFORE AND AFTER TREATMENT

Ninety days after the test is complete or 1 year after receipt of waste (whichever comes first)

5. LOCATIONS WHERE TREATMENT OR STORAGE WILL OCCUR

Biological: 324, 325 and 331

Thermal: 324, 325, 331, and ISV Test Site

Physical/Chemical: 324, 325, 327, 329, 3720, 1706-K Building (100-K Area), and lysimeter locations

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Author	T. D. Chikalla 6-2239 P7-75	Addressee	Mr. Roger F. Stanley Hanford Project Manager State of Washington Department of Ecology Olympia, Washington 98504-8711
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