MIXED WASTE TREATMENT AT THE IDAHO NATIONAL ENGINEERING LABORATORY*

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ABSTRACT

The Idaho Operations Office of the Department of Energy (DOE) made the decision in 1984 to prohibit the disposal of mixed waste (MW) in the Idaho National Engineering Laboratory (INEL) low-level radioactive waste (LLW) disposal facility. As a result of this decision and due to there being no EPA-permitted MW treatment/storage/disposal (T/S/D) facilities, the development of waste treatment methods for MW was initiated and a storage facility was established to store these wastes while awaiting development of treatment systems. This report discusses the treatment systems developed and their status.

INTRODUCTION

The first two types of MW chosen for treatment consist of: (1) those wastes that are combustible, and (2) those wastes that are hazardous due to toxic metals. It was decided that a liquid system should be added to the existing INEL incinerators to process the liquid combustible MW. The MW with the toxic metals would be stabilized by solidification. Both processes, incineration and stabilization, would render the MW nonhazardous (with the exception of listed wastes) and therefore allow disposal as LLW.

In addition to INEL-generated wastes, other DOE sites in the western United States have expressed an interest in shipping wastes to the INEL for incineration. These wastes would include solid and liquid hazardous and mixed wastes. The strategy to implement this was evolved through the DOE Hazardous Waste Remedial Action Program by a Western Region committee composed of affected DOE site representatives. This action would significantly increase the volume to be processed and would require both INEL incinerators.

A Resource Conservation Recovery Act (RCRA) Part B permit application has been submitted to EPA Region X which includes storage facilities for HW and MW, the Process Experimental Pilot Plant (PREPP) and Waste Experiment Reduction Facility (WERF) incineration systems, and the WERF stabilization system. The INEL is, at the present time, awaiting Environmental Protection Agency (EPA) action on the RCRA Part B permit application and decisions on interim status to begin production operations.

MIXED WASTE INCINERATION CAPABILITIES

The INEL has two incineration systems, the WERF incinerator and the PREPP incinerator. The WERF incinerator is a dual chambered controlled air incinerator and was designed to process LLW. The PREPP incinerator is a rotary kiln incinerator and was designed to process transuranic (TRU) waste.

WERF Incineration

The WERF LLW incinerator is rated at 5-MM Btu/h and has been successfully processing combustible LLW since September, 1984. In 1985 and 1986 a liquid waste system was designed and installed in the WERF incinerator. The liquid system consists of a vortex burner rated at 1.3-MM Btu/h, control system, and feed system. Since the quantities of liquid combustible MW generated at the INEL are relatively small, the waste is pumped directly from 55-gallon drums. In addition to the processing of liquid HW, testing was performed on processing solid hazardous waste. The tests successfully demonstrated the capability of burning solid hazardous waste by absorbing hazardous liquids on combustible absorbent and processing through the incinerator via the solid LLW feed system.

In November 1986, a RCRA trial burn was successfully conducted and the trial burn report was transmitted to EPA Region X in February 1987.

PREPP Incineration

The PREPP TRU incinerator is currently undergoing initial operational testing and has been used to process test quantities of classified solid wastes. A liquid waste system is currently being designed to allow the processing of liquid

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hazardous waste. The liquid system will consist of a feed system and a liquid waste burner rated at 5-M Btu/hr in the secondary chamber.

A RCRA trial burn plan has been submitted to EPA Region X for both solid and liquid hazardous wastes. The facility currently has interim status under RCRA.

MIXED WASTE SOLIDIFICATION

Wastes which are hazardous due to toxic metals are classified as "characteristic" wastes by RCRA. Wastes suspected of being characteristic are analyzed for toxic metals by the Extraction Procedure (EP) leach test [or the more current Toxicity Characteristic Leaching Procedure (TCLP)]. The primary waste streams with toxic metals at the INEL result from the processing of LLW at the WERF facility. The flyash and bottom ash from the WERF incinerator contain excessive levels of cadmium and lead and the baghouse dust from the metal size reduction (plasma torch) system contains high levels of chromium. Other sources of waste contaminated with toxic metals result from INEL decontamination and decommissioning (D&D) activities at the INEL and consist primarily of soil and sludges contaminated with mercury and other metals. Treating wastes determined to be hazardous by the EPA leach test, so they would pass the leach test, would result in a waste form which is no longer hazardous and could be therefore disposed of as LLW.

Since these wastes are collected in drums and the volumes of each of these wastes streams is relatively small, in-drum mixing with cement was chosen as the most economical method to stabilize these characteristic wastes. The system consists of a 55-gallon drum tumbler, an in-drum mixer, and a grout mixer for adding the cement/water mixture to the waste. Also, since each waste stream is different, a unique formula (ratio of waste, cement, and water) for each waste stream must be developed. Solidification formulas have been successfully developed for the incinerator flyash and bottom ash, plasma torch baghouse dust, soils and sludges contaminated with mercury, and for zirconium fines.

Incinerator Bottom Ash and Flyash

An extensive development program was conducted for stabilization of the incinerator bottom ash and flyash. Based on the extensive development program and testing results, INEL received a letter from EPA Region X approving this concept and essentially giving approval to dispose of the treated ash as LLW. The first phase was the bench scale development where "dixie" cup size samples were tested to evaluate different media and to determine the best ratio of waste to binder and water. Several media were tested; specifically, portland cement, combinations of cement and sodium silicate, and "Envirostone". The results were compared by the effect on the leachability of the heavy metals. Portland cement was the solidification agent chosen since it achieved the desired leachability results, was easy to work with, and was the least expensive of the binders tested.

After the bench scale tests were completed, drum scale tests were conducted. The ratio of binder to waste and water which resulted from the bench scale tests proved to be too stiff requiring several alterations of the ratios to optimize the waste form. Although drum 1 (see Table I) passed the TCLP leach test, it contained excessive moisture and required an extensive drying time. Drums 2 and 5 contained too little moisture, making it difficult to obtain a consistently homogeneous mixture; these drums failed to satisfy EPA criteria. After the mixing technique was established and the binder to waste ratio optimized, all remaining drums passed the TCLP leach test.

Sampling is performed by inserting a piece of PVC tubing into the mixture before it sets up and extracting the resultant core sample from the tube for analysis. (See Fig. 1.) After the solidification process is established, samples are taken from each drum. However, only samples from one drum out of every ten drums are analyzed and the other nine are archived and only analyzed if the first drum fails the analysis.

Mercury-Contaminated Soils and Sludges

Another waste which required extensive sampling and a development program is waste resulting from the D&D of the Initial Engine Test (IET) facility. The waste tank and the line to the tank had been contaminated with mercury when the facility was operational. The D&D of the IET facility resulted in 72 drums of tank and pipe sections, soil, sludge, and absorbent.

An extensive testing program was conducted to determine the levels of mercury and the best methods for treating each waste type. The TCLP was used for the leach test and resulted in a wide variety of results. In fact, some samples which contained visible amounts of metalic mercury tested below the 0.2 mg/L level. Therefore, a test program was developed to evaluate the use of the TCLP on mercury-contaminated wastes. Soil samples were spiked with varying amounts of mercury from 5 g mercury with 95 g soil to 50 g mercury and 50 g of soil. A 100 g sample of mercury with no soil was also tested. The results are shown in Table II. The low leach rates for the mercury mixed with soil is surprising. The results indicate that it is possible for a mixture of 1% mercury with 99% soil to test below the 0.2 mg/L level. These results indicate that the TCLP test may be inadequate for mercury-contaminated wastes.

Bench scale solidification testing for the soil and sludge was successful in reducing the leach rate to acceptable levels. These results are however, using the questionable TCLP.

TABLE I

Analytical Results of Leach Test Flyash.

Drum Number	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
	Analtye Concentration Detected (mg/L)							
Raw Flyash TCLP Results[a]								
1	<0.01	0.8	155.0	<0.01	34.6	0.0016	0.02	0.11
2	<0.01	0.2	297.0	0.19	88.5	0.007	0.05	0.03
3	0.03	0.3	136.0	0.3	28.0	0.0092	0.06	0.09
4	0.02	0.1	169.0	0.1	212.0	0.0004	0.05	0.19
5	0.01	0.1	438.0	0.1	130.0	0.0004	0.05	0.14
6	0.01	0.4	77.2	0.1	33.5	0.0037	0.04	0.13
7	0.01	0.1	366.0	0.1	125.0	0.0004	0.03	0.14
8	0.01	0.1	305.0	0.5	168.0	0.0004	0.02	0.13
9	0.01	0.2	202.0	0.05	59.0	0.0004	0.04	0.68
Solidified Flyash TCLP Results[b]								
1	--	--	0.01	--	0.4	--	--	--
2	--	--	0.4	--	37.5	--	--	--
3	--	--	0.005	--	0.52	--	--	--
4	--	--	0.005	--	2.0	--	--	--
5	--	--	68.4	--	12.0	--	--	--
6	--	--	0.005	--	2.0	--	--	--
7	--	--	0.005	--	1.2	--	--	--
8	--	--	0.005	--	0.08	--	--	--
9	--	--	0.03	--	1.2	--	--	--

a. Highest result of 4 dry core samples per drum.

b. Highest result of 4 wet core samples per drum.

Fig. 1. Removal of a Probe Sample of Solidified Flyash.

Zirconium Fines

There are large volumes of radioactively contaminated zirconium fines at the INEL. The radioactive waste disposal facility will not accept zirconium due to its pyrophoric properties. A solidification test program was conducted to verify that zirconium fines mixed with cement would no longer be pyrophoric.

The test program was designed to process zirconium fines which were reading up to 5-R/h (on contact) due to activated stainless steel chips which were also present. A disposal plan using one-gallon can of cement/water mixture and 100-g of zirconium chips was chosen in the interest of reducing the radiation fields. Further reduction in radiation fields will be obtained by placing these one gallon cans in a 55-gallon drum of cement.

The first test was conducted using 100 g of nonradioactive zirconium fines. Thermocouples (TCs) were placed in the monolith (see Fig. 2) to measure the temperature of hydration and evaluate if there was any reaction with zirconium during the test. The monolith was placed in an oven and heated to 130C while monitoring the TCs. The test temperature was chosen to simulate 2-1/2 times the maximum temperature that would be seen in the disposal pit prior to or after being covered with soil (with the exception of a fire in the pit).

After the monolith was heated for 16 hours and allowed to cool, with no effect on the zirconium, the monolith was broken into small pieces and repeatedly subjected to an open flame. No self-sustaining pyrophoric reactions were produced. As expected, mixing zirconium fines in a cement/water mixture produces a waste form which can be safely disposed of in the radioactive waste disposal facility as LLW.

FUTURE PLANS AND DEVELOPMENTS

Off-Gas System Upgrades

The WERF incinerator off-gas system is currently a dry filtered system which cools the incinerator combustion gases by means of both air dilution and passage through a shell and tube, gas-to-air heat exchanger. The cooled gases are passed through a fabric filter baghouse and then through high efficiency particulate air (HEPA) filters prior to discharge to the atmosphere. The off-gas is continuously monitored for radioactivity and for acid content. Waste generators are required to segregate materials which may generate large quantities of acid-forming compounds.

The present design is adequate for incineration of LLW since the waste stream can be controlled by restricting halogenated materials. However, many hazardous combustible wastes are chlorinated and to maximize the incinerator's capability to process hazardous wastes a scrubbing system is required. The need to minimize secondary waste streams is also still a requirement. Since the WERF incinerator was installed in 1984 a new off-gas scrubbing system has been developed which generates no secondary liquid waste stream. The dry scrubbing system uses an evaporative cooler to introduce a neutralizing agent for hydrochloric acid (HC1) removal. In the evaporative cooler, HC1 reacts with the neutralizing agent forming a salt particulate which is removed in the baghouse. All of the water used is evaporated in the evaporative cooler leaving no liquid waste streams to deal with. Additional HC1 removal occurs in the baghouse as the flue gas passes through a cake of neutralizing agent on the surface of the baghouse bags.

The conceptual design for the installation of a "dry" scrubbing system in the WERF off-gas system is in progress. Final design is expected to be completed by the end of FY-88. Additional funding is required to install the system.

Liquid Waste System Upgrades

The present liquid system was sized to process INEL-generated mixed waste. Since the installation of the system, an activity has been underway to develop a strategy to process DOE-generated hazardous and mixed waste on a regional basis. The purpose of this strategy development is to maximize the use of existing facilities and to minimize the need for incinerators at each site. The WERF incinerator plays a major role in this strategy and will therefore require an increase in the capacity of the system from the present 1.3-MM Btu/h to 5.0-MM Btu/h. The feed system will also require upgrading. The conceptual design for these system upgrades has been initiated. The actual upgrades will not be made until the regional strategy has been approved.

Solidification System Evaluations

The present WERF solidification system is working well. However, evaluations are being made to add a batch system that would permit the use of the grout to fill voids in other waste containers. This practice would not only reduce the number of waste containers requiring disposal but would minimize the void spaces in waste sent to the disposal facility and would therefore also minimize future subsidence. Boxes of sized metal and boxes from the compactor which can not be completely filled are two examples of waste containers with voids. There are also vessels generated from the D&D of surplus facilities which could be filled with grout prior to disposal. Additionally, there are radioactively-contaminated soils with hazardous constituents which may require solidification in the near future. A batch system would be the most effective system for processing soils.

The batch system would consist of a grout mixer(s) for mixing the waste and subsequently transferring it to the waste container with the transfer pump. The size of the

TABLE II

IET Waste Test Results (mg/L).

Sample Number Type	HG Max 0.2	Comments
IET - SW1B Pure Soil	0.0023	Per EPA TCLP Tests
IET - SW2B Soil + 5% Hg	1.2	Per EPA TCLP Tests
IET - SW3B Soil + 10% Hg	3.7	Per EPA TCLP Tests
IET - SW4B Soil + 20% Hg	10.2	Per EPA TCLP Tests
IET - SW5B Soil + 30% Hg	19.6	Per EPA TCLP Tests
IET - SW6B Soil + 50% Hg	48.5	Per EPA TCLP Tests
IET - SW7B 100% Hg	422.0	Per EPA TCLP Tests

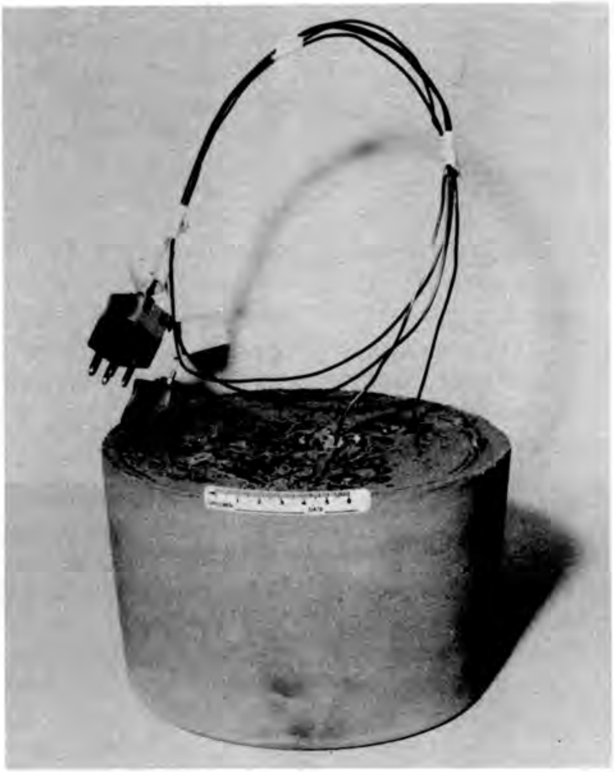

Fig. 2. Cement Monolith Laced With Zirconium Fines Before Heating.

grout mixer and transfer system will depend on the volume of waste identified for processing.

SUMMARY

The INEL has the capability to process some forms of MW and is in the process of modifying or providing additional capabilities. Incineration of combustible MW, when performed in a properly designed and operated incinerator, provides both volume reduction and destruction of the hazardous components. Incineration, coupled with solidification/stabilization of the resulting residues, provides an excellent waste form for environmentally safe disposal. Solidification of characteristic hazardous wastes which bind the metals and adequately reduce or eliminate the leachability, also provides an environmentally safe waste form.

The INEL is committed to the treatment of MW to render it nonhazardous where possible and/or to provide an improved waste form for disposal.

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