THE RESULTS OF THREE DOE SPONSORED WASTE TREATMENT TECHNOLOGY DEMONSTRATIONS

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ABSTRACT

This paper describes the results of three DOE sponsored waste treatment technology demonstrations of Clean Technologies International Corporations' chemical reduction waste treatment process. The Ashtabula DOE site demonstration was a simple proof-of-concept sponsored program. The work at Sandia National Laboratories was a proof-of-principle demonstration, and the Savannah River demonstration was a proof-of-performance level of effort. DOE and NETL sponsored a final waste treatment technology shoot-out. The demonstrations waste treatment objectives, the waste treatment results, and lessons learned are presented.

INTRODUCTION

Clean Technologies International Corporation, of Reno, Nevada, has developed and patented the use of naturally occurring highly chemically reactive alkaline metals to treat waste. These metal alloys, held liquid at 900 degrees Celsius, have been found to destroy all organic compounds, all halogenated organic compounds, while separating and dissolving all radioactive metals.

Six nines levels of waste destruction have been demonstrated at these DOE sites for all waste types processed, including PCBs, hard plastics, and the permanent safe stabilization of pyrophoric uranium, thorium, and strontium. Chemical reduction has been shown that no off-gas air emissions are ever generated.

ASHTABULA RESTORATION MANAGEMENT PROJECT

These proof-of-concept technology demonstration treatment objectives were:

- To test the ability of chemical reduction for the treatment of PCB contaminated soils
- To test the treatment of uranium/PCB contaminated soil
- To test the treatment of pyrophoric uranium covered with very dense organic antioxidants
- To test the treatment of a DOE halogenated liquid floor and wall stripper

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The proof-of-principle treatment objectives were:

- The treatment of DOE radioactive batteries
- The treatment of DOE laboratory organic "Lab Trash"
- The "shape changes" treatment of radioactive classified materials
- The treatment and subsequent separation from heterogeneous matrices and the stabilization of tritium

SAVANNAH RIVER ARSENAL

This proof-of-performance waste treatment demonstration was a NETL/DOE sponsored "Technology Shootout", in the DOE EM 50 sponsored Alternatives to Incineration Program.

The proof of performances objectives for each of the technologies tested was:

- To demonstrate the ability of the technologies to destroy all of the hydrogen generating organic materials
- To demonstrate the technologies ability to separate and stabilize plutonium and other radionuclides
- To demonstrate that the technologies did not produce any off-gas air emissions or produce any dioxins or furans
- To demonstrate the technologies ability to simultaneously treat complicated mixtures of DOE waste materials.

The four alternatives to incineration technologies tested were:

Thermal Desorption

Supercritical Oxidation

Electrical Chemical Oxidation

Chemical Reduction

The Savannah River waste treatment technology Demonstration "shootout" was for the "Destruction of Organics in TRU Waste." This program was for the DOE to find a technology to solve the radiolysis problem and the shipment and storage problems of hydrogen generation mixtures of organic materials and radioactive metals.

ASHTABULA

The primary interest of the Ashtabula DOE testing program was to demonstrate the ability of chemical reduction to render DOE site soils, contaminated with PCBs and metals, so that they could become landfillable.

The proof-of-concept testing consisted of actual PCB contaminated site soils whose PCB concentration was around 190 PPM. The EPA landfill requirements allow no more than one PPM residual PCBs.

A total of 1099.94 grams of 190 PPM PCB contaminated "compacted" clay disk soils were processed to .150 PPM of PCBs, which represented the total PCBs still detectable in the treated clay soil residues.

These soils, treated by chemical reduction to this level, were now landfillable under EPA rules, because they were now less than one PPM.

The mass balances for this proof-of-concept treatment of PCB contaminated soils are:

- 190 PPM-.15PPM = 189.5/ 190 x 100% = 99.92% PCB removal efficiency from the soil.
- Destruction efficiency of the removed PCBs is based on any residual PCBs found in the scrubber water and/or charcoal filters.
- Scrubber water 1 showed a total of .0023 ppm.
- Scrubber water 2 showed .00054 ppm.
- Charcoal filter showed .018 ppm.

    1- (0.254mg/109mg) 100 = 99.99 % destruction of the PCBs removed from the soil.

The second objective was to demonstrate the removal of uranium from the clay soils. This one demonstration was not physically possible because we did have the right equipment for this particular demonstration. With the compacted clay sample furnished, the required mixing of the soil with the metal alloy could not be done.

The third objective was to demonstrate the stabilization of pyrophoric uranium.

When the pyrophoric uranium was submerged into the liquid metal chemically reductive bath, the organic antioxidant was converted to carbon particulate and hydrogen gas. The uranium dissolved into the liquid bath and became a part of the alloy.

The chemically reduced uranium was no longer pyrophoric and was still stored and stabilized in a cooled metal ingot. The uranium, and any other alloyed metal, can be reclaimed from the alkaline metal ingot by temperature differentiation.

The final treatment objective involved the continuous subsurface injection of liquids.

A very troublesome problem for the DOE is the treatment of radioactive halogenated organic floor and wall strippers. The floor stripper treated was composed of pure undiluted methyl chloride, methyl alcohol, aminoethanol, and dodecylbenzene sulfonic acid. The floor stripper was continuously pumped subsurface into the liquid metal bath.
Complete chemical reduction destroyed all of these halogenated liquid organic substances, all without any off-gas air emissions.

The off-gas air emissions were continuously monitored during treatment. No abnormal air emissions were generated during any of the technology demonstrations.

SANDIA NATIONAL LABORATORIES

One of the primary objectives of this DOE sponsored technology demonstrations was to prove that classified radioactive control systems and software could be "face changed" to the point that they could not be reverse engineered.

All shapes tested were changed beyond recognition.

Another objective was the verification of the ability of chemical reduction to treat every conceivable kind of DOE organic "lab trash."

The "lab trash" tested, consisted of industrial batteries, Kim Wipes, paper towels, filter paper, duct tape, ear plugs, printed circuit boards, lunch sandwiches, nitrile gloves, Tyvek booties, plastics and metal clips, and hard "plastics".

These are the types of materials that give chemical oxidizing technologies problems.

All of these materials were completely and safely treated with the CTIC chemical reduction process.

Chemical reduction processed everything that Sandia could find to process.
All materials were chemically processed without any off-gas air emissions or the production of dioxins or furans.

The simple R & D level treatability unit used at Sandia consisted of just 50 pounds of the chemically reactive alkaline metal alloy.

This small bench-scale sized treatability unit, with limited thermal mass, was manually operated and was not designed to be able to thermally process some of the amounts of the very concentrated high BTU- consuming plastic polymers inserted into it all at one time.

Due to the physical limitations of the equipment and operator BTU overloading, some products of incomplete chemical reduction were observed. These were not vented but were fully contained within the PAS equipment.

Some of the aromatic contaminants of the plastics escaped the treatment bath unreduced and were trapped in the aqueous scrubbers. Of regulatory concern was aromatic benzene. No benzene escaped the treatment unit's PEC equipment. All was contained.

It needs to be noted that with chemical reduction, any secondary materials captured in water, bags, ESPs, or charcoal can all be reprocessed.

One final objective was to test the aqueous scrubber's ability to absorb tritium released from the treatment of heterogeneous triturated waste.

Results of this proof-of-principle treatability study, with an R & D level machine, were:

Everything tested was chemically processed; all was destroyed beyond recognition, leaving only the atoms that comprised the waste.

Chemical reduction does not produce any dioxins or furans.

Chemical reduction does not produce any off-gas air emissions.

This process is viable for the destruction of DOE classified items.

Chemical reduction is viable for the destruction of all DOE lab trash.

The waste samples tested which contained the tritium had been mischaracterized and had higher concentrations of radioactive tritium than expected. This made the off-gas too radioactively hot for the small aqueous scrubbers. This unexpectedly large release of tritium over-whelmed the small aqueous scrubbing system.

Except for the mischaracterization of the waste, the treatment objective worked as expected. The tritium was separated from the heterogeneous mixtures, which were chemically destroyed. This then freed the tritium for stabilization. There were no off-gas air emissions, except for the tritium.

LESSON LEARNED

Never trust someone else's waste characterization data.
Never trust anyone with your technology without ultimate control.
Have signed test plans.

SAVANNAH RIVER

The DOE sponsored a final technology "shootout" between the four current surviving "alternatives to incineration" technologies: CTIC's Chemical Reduction, Supercritical Oxidation, Electrochemical Oxidation, and Thermal Desorption.

This DOE sponsored technology demonstration program was for the "Destruction of Organics in TRU Waste."

A new commercial-scale unit was utilized for this final proof-of-performance demonstration. This unit contained 1500 pounds of the chemically reactant liquid metal alloy.

This unit, unlike the small treatability unit, had the thermal mass to completely destroy all of the "hard plastics" and all of their aromatic components.

Complete chemical reduction destroys any and all aromatic compounds, chemically reducing them to carbon, CO, CO2, and hydrogen.

No aromatics compounds escaped to the PAS equipment or formed during this demonstration.

One objective of this demonstration was to destroy the hydrogen generating organics and stabilize the TRU metals.

Another objective was the elimination of hydrogen generation by the complete destruction of all organics from the radioactive metals.

To accomplish these goals, surrogate mixtures of many varied organic materials, along with mixtures of metals. This includes the plutonium surrogate CeO. The metals, glass, acids, bases, nitrates, and salts were all processed simultaneously. All was destroyed, including the metal container. This proved that a larger scale unit will be able to process whole drums of waste, including the drum itself.

Also, to further verify that dioxins or furans are never produced; large volumes of the precursor of dioxins, perchloroethane, were also processed along with all of the mixtures.

Water was also included in the matrixes.

Each gallon metal container was loaded with the organic combustibles, including polypropylene, polyethylene, PVC pipe, and cellulose soaked with oil.

The metals included in each container were Cu, Cd, Mg, CeO, Fe, Ni, Cr, and Pb.

HCE, Hg, water, HCl, and NaOH were also added to each "barrel".

The whole "barrel", containing the complete mixtures of materials, was dunked into and held beneath the surface of the highly chemically reactive liquid alkaline metal bath.

Upon completion of the treatment cycle, the dunker was raised. Nothing was left of the metal barrels, the organic material, or any of the metals. All the physical material disappeared during treatment.

All that was left of the materials processed was elemental carbon captured by the cyclone separator. All the metals processed dissolved into the alloy, as verified by metal analysis. 2%-3% hydrogen in the off-gas, and small CO spikes as the organics were destroyed.

Savannah River and the DOE, said that Clean Technologies won the shootout hands down and recommended that the DOE began utilizing this technology to solve some of the DOE very troublesome waste streams treatment problems.

A summary of the waste treatment results from the three DOE sponsored waste treatment demonstrations:

- No dioxins or furans were generated.
- No off-gas air emissions were produced.
- No aromatic compounds were generated.
- No secondary materials were generated.
- All of the metals tested dissolved in the alloy were accounted for.
- The Pu surrogate were reduced to pure metals and alloyed.
- The volatile metals were captured by the PEC equipment, as planed.
- Everything organic was converted to carbon graphite.
- Halogenated hydrocarbons were converted to salts and graphite.
- No pretreatment or post-treatment of any waste was required.
- Radioactive materials were chemically separated from the heterogeneous materials.
- Radioactive metals were alloyed and stabilized.
- Volatile radioactive materials were captured and stabilized.

CONCLUSION

The Savannah River DOE said that "Clean Technologies' Chemical Reduction Waste Treatment Technology is the environmentally friendly alternative to incineration." The reason that chemical reduction is superior to incineration is that chemical reduction does not emit acid rain, NOXs, HCl, dioxin, or furans. Chemical reduction also does not produce EPA listed fly ash. Unlike incineration, Chemical reduction can handle all the metals, leaving none in the treated residuals. All metals are stored in the treatment ingots for storage or reclamation. All metals can be reclaimed from the ingots. All that chemical reduction vents o the atmosphere is Hydrogen, CO, CO2, and water vapor.