

ABSORBING WIPP BRINES: A TRU WASTE DISPOSAL STRATEGY

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ABSTRACT

Los Alamos National Laboratory (LANL) has completed experiments involving 15 each, 250-liter experimental test containers of transuranic (TRU) heterogeneous waste immersed in two types of brine similar to those found in the underground portion of the Waste Isolation Pilot Plant (WIPP). To dispose of the waste without removing the brine from the test containers, LANL added commercially available cross-linked polyacrylate granules to absorb the 190 liters of brine in each container, making the waste compliant for shipping to the WIPP in a Standard Waste Box (SWB). Prior to performing the absorption, LANL and the manufacturer of the absorbent conducted laboratory and field tests to determine the ratio of absorbent to brine that would fully absorb the liquid. Bench scale tests indicated a ratio of 10 parts Castile brine to one part absorbent and 6.25 parts Brine A to one part absorbent. The minimum ratio of absorbent to brine was sought because headspace in the containers was limited. However, full scale testing revealed that the ratio should be adjusted to be about 15% richer in absorbent. Additional testing showed that the absorbent would not apply more than 13.8 kPa pressure on the walls of the vessel and that the absorbent would still function normally at that pressure and would not degrade in the approximately $5e-4$ Sv/hr radioactive field produced by the waste. Heat generation from the absorption was minimal. The *in situ* absorption created a single waste stream of 8 SWBs whereas the least complicated alternate method of disposal would have yielded at least an additional 2600 liters of mixed low level liquid waste plus about two cubic meters of mixed low level solid waste, and would have resulted in higher risk of radiation exposure to workers. The *in situ* absorption saved \$311k in a combination of waste treatment, disposal, material and personnel costs compared to the least expensive alternative and \$984k compared to the original plan.

PURPOSE AND INTRODUCTION

The purpose of this experiment and subsequent process was to remove excess liquids from a transuranic (TRU) waste stream so that the waste could be packaged to meet criteria for disposal at the Waste Isolation Pilot Plant (WIPP). Experimentation showed that brines similar to those found in the underground portion of the WIPP near Carlsbad, New Mexico, can be effectively absorbed to create a liquid free matrix that meets the requirements of the RCRA permit issued for the operation of WIPP, that is, less than 1% liquid in the shipping container, less than one inch liquid in any internal container, and less than 1% liquid in the aggregate of all internal containers within the shipping container. The *in situ* absorption was the safest, fastest, and least costly of the alternatives studied, saving as much as \$311k(1) to \$984k in the combination of costs for waste treatment and disposal and for material, facilities and personnel(2).

Los Alamos National Laboratory (LANL) had an inventory of waste including about 2800 liters of brine at the completion of the Actinide Source Term Waste Test Project (STTP) in 2000. The waste was 15 each, 250-liter experimental test containers (Fig. 1) of actual TRU heterogeneous waste immersed in two types of brine. LANL explored several alternatives for disposing of this waste.



Fig. 1 250-liter Containers With WIPP-type Brine and Waste

1. Pumping the brine out of the test containers and managing it as Low Level Waste (LLW), leaving the wet heterogeneous waste in the test containers, remediating the liquid condition, and packaging it in Standard Waste Boxes (SWBs). This would have had the following waste streams, costs and risks.
 - 2500 liters of waste water (LLW) to be shipped off site for treatment and shipped again for disposal
 - 8 SWBs (TRU) containing the 15 titanium test vessels with absorbent added to remediate any potential excess liquid condition
 - personnel time ~ \$320k
 - disposal costs ~ \$111k (LLW) and \$553k (TRU)

- risk in shipping and handling liquids; risk in off site treatment and additional shipping from there.
2. (Original Proposal) Pumping the brine out of the test containers and managing it as Low Level Waste (LLW), repackaging the wet heterogeneous waste into 55-gallon shipping containers. This would have had the following waste streams and costs.
- 2500 liters of waste water (LLW) to be shipped off site for treatment and shipped again for disposal
 - 15 drums of TRU waste
 - 15 titanium vessels to be disposed of as LLW
 - personnel time ~ \$640k
 - facility modification and program equipment ~ \$750k
 - disposal costs ~ \$113k (LLW) and \$107k (TRU)
 - risk of worker exposure in handling TRU waste; risk in shipping and handling liquids; risk in off site treatment and additional shipping from there.
3. (Selected Alternative) Absorbing the brine *in situ* in the test containers and packaging them in Standard Waste Boxes (SWBs). This would have had the following waste streams and costs.
- 8 SWBs (TRU) containing the 15 titanium test vessels with absorbent added to remediate any potential excess liquid condition
 - personnel time ~ \$120k
 - disposal costs ~ \$553k (TRU)
 - risk of spill during liquid transfers.

On the basis of experiments(3) that showed the absorption process was effective, and also based on a cost saving of over a million dollars (offset by a minor increase in disposal costs) LANL chose option 3, the *in situ* absorption of liquids and subsequent packaging into SWBs. The disposal approach was approved by the Los Alamos Area Office of the Department of Energy with concurrence from the LANL Transuranic Waste Characterization/Certification Project(4). Regulatory experts from LANL agreed that adding absorbent to the containers with liquid met the intent and requirements of the RCRA rules governing treatment, absorption, and packaging(5).

A brief summary of the absorption experiments supporting LANL's decision follows.

- Two types of brine, Brine A and Castile Brine, were used in absorption experiments. These are sodium, magnesium and potassium chloride brines with some lesser salt constituents typical of the WIPP environment. About 50ml of brine was put into a beaker and Aquasorbe-2212® cross-linked polyacrylate polymer was added in an initial ratio of 1 part absorbent to 10 parts brine and the mixture was observed (Fig. 2). More absorbent was added as necessary until full absorption was observed by tipping the beaker and seeing that no brine moved within the interstices of the absorbent matrix. A volumetric ratio of 1 part absorbent to 10 parts Castile Brine and 1 part absorbent to 6.25 parts Brine A was determined. Up to 30% expansion was seen at full absorption.



Fig. 2 Absorbent Material and Some Test Apparatus

- The manufacturer of the absorbent performed independent tests that showed the absorbent would not put more than 13.8 kPa pressure on the walls of the container if constrained but that absorption would not be inhibited by the pressure. Additional tests at LANL showed that uncapping the container would not lead to sudden extrusion of the constrained absorbed mass.
- Two bottles packed with waste-like materials were prepared and filled with brine, leaving a small headspace. The correct amount of absorbent was added to each bottle and the caps put on. The bottles were gently rolled on a bench top to simulate agitation of the 250-liter waste containers. The absorbent became evenly distributed throughout the bottles and the brines were completely absorbed.

LANL also absorbed 1-liter samples of actual brine from STTP test containers to verify that the ratios of absorbent to brine were correct.

FULL SCALE MOCKUP TESTING

LANL also had two 250-liter test containers with about 170 liters of non-radioactive brine each. Waste-like material consisting of lab coats, booties, gloves, glassware, cheesecloth, and bags was added and the drums were sealed except for a ¾-inch (about 2.5 cm actual size) pipe threaded hole in the top. Using a HEPA filtered steel funnel, absorbent was added through the hole and then the hole was plugged. The drum was set horizontally on a roller and rotated about its long axis for 15 minutes to agitate the mixture and assure complete mixing. A thermocouple attached to the outside of the container showed a temperature rise of about 2°C for less than a minute immediately after the rotation. A slight pressure build up was observed during the agitation.

Then the drum was opened and the matrix inspected (Fig. 3). Even though the material passed the paint filter test(6), when a container was placed on its side and a valve at the bottom was opened for two months, about 200cc of sticky syrup leaked from the valve. The test material met the criteria for no excess liquids, but LANL increased the ratio of absorbent 15% for added assurance. All the tests clearly showed that the absorbent would be effective at remediating the excess liquid condition.



Fig. 3 Absorbed Brine and Mock Waste Materials

One of the major concerns for waste handlers was whether the full amount of absorbent would fit in the test containers. LANL performed a $P_1V_1=P_2V_2$ measurement of the headspace of each container and found a barely sufficient space to add absorbent given that the absorbent packing fraction was about 0.5, that is the absorbent would displace 5 liters of liquid for 10 liters added. To deliver all the absorbent would require enough free space in the container to allow the free flowing granules to sink. This was a condition not achieved in the actual drums.

About 2 ½ inches below the lid of each container there was a coarse screen to hold waste away from the sampling ports of the containers. In order to allow freer flow of absorbent into the brine, LANL cut a 2.2 cm diameter hole in the screen using a hole saw. However, the plastic waste materials were lighter than the brine and floated up to the screen and stopped, thus blocking the

newly formed hole as well as most of the mesh. To solve the blockage LANL pumped about 120 liters of brine from the container into a temporary storage tank so that there would be a large headspace into which to pour the absorbent, after which the liquid would be pumped back into the container. The containers were agitated by rolling them gently about their long axis for 15 minutes, after which the lids were fitted with a WIPP certified filter vent. In some containers not all the brine could be returned to the original vessel so it was absorbed separately in a plastic bag (Fig. 4).



Fig. 4 Bag of Absorbed Extra Waste

SWB PACKAGING

After absorption the containers were set two at a time into SWBs along with associated experimental piping and the extra absorbed brine, and a valve on each was locked open, further assuring that the containers were not pressurized. The fit was quite precise but to assuage fears that the contents would move, vermiculite was added to the SWBs. The vermiculite also created an additional measure of safety should liquid ooze from the containers. LANL TWCP visual examination experts assisted in the packaging to give the highest probability that this waste stream can be disposed at WIPP.

Safety Concerns

One reason that alternative #3 was chosen was that it would expose workers to less radiation and potential contamination than either of the other two. No contamination was detected during the month required to complete the operation.

CONCLUSIONS

Excess liquid conditions can be safely and inexpensively eliminated by adding a cross-linked polyacrylate polymer absorbent to a container holding WIPP-type brines. However, the reader is cautioned that in order to maintain RCRA compliance the absorbent should be added at the first time the shipping package is prepared or should be added to the waste prior to packaging. Adding absorbent to the shipping container after initial packaging should be addressed as a regulatory issue separate from the process described here.

SIGNIFICANCE OF THE PAPER

This research shows that a cross-linked polyacrylate polymer can be used to absorb chloride brines. This paper shows that significant cost savings can be realized from absorbing liquids in waste containers at the time of packaging as opposed to opening a container, separating the components and treating or packaging them separately. The cost savings and risk avoidance this method provides could save generators of aqueous TRU waste products a great deal of money as well as making it safer to dispose of the waste.

REFERENCES

- ¹ All disposal costs are derived from the rates listed on the LANL web site <http://wm99.lanl.gov/recharge/owa/Rates>. The rate for TRU waste storage/certification/disposal in August 2000 was \$34,550 per cubic meter and the cost for mixed low level waste was \$44,200 per cubic meter.
- ² From LANL staff rates for the year 2000 and estimates of fabricating, installing and operating a glovebox.
- ³ Yeaman, David R., Absorbing WIPP Brines With a Cross-Linked Polyacrylate Absorbent, LA-UR-00-5211, Los Alamos National Laboratory, 2000.
- ⁴ Meeting with DOE, LANL TWCP and NMT-11, 11/21/2000.
- ⁵ e-mail from Edward L. Horst, LANL, NMT-7, 10/25/2000.
- ⁶ EPA method SWA-846-9095, Paint Filter Liquids Test.