DEMONSTRATION OF THE BULK VITRIFICATION PROCESS AS A SUPPLEMENTAL TREATMENT TECHNOLOGY FOR LOW ACTIVITY TANK WASTE AT HANFORD

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ABSTRACT

The DOE Office of River Protection (ORP) is managing a program at the Hanford site that will retrieve and treat more than 200 million liters (53 million gal.) of radioactive waste stored in underground storage tanks. The waste was generated over the past 50 years as part of the nation's defense programs.

The project baseline calls for the waste to be retrieved from the tanks and partitioned to separate the highly radioactive constituents from the large volumes of chemical waste. These highly radioactive components will be vitrified into glass logs in the Waste Treatment Plant (WTP), temporarily stored on the Hanford Site, and ultimately disposed of as high-level waste in the offsite national repository. The less radioactive chemical waste, referred to as low-activity waste (LAW), is also planned to be vitrified, and then disposed of in approved onsite trenches. However, additional treatment capacity is required in order to complete the pretreatment and immobilization of the LAW by 2028, which represents a Tri-Party Agreement milestone.

To help ensure that the treatment milestones will be met, the Supplemental Treatment Project was undertaken. The project, managed by CH2M HILL Hanford Group, Inc., involves the testing, evaluation, design, and deployment of supplemental LAW treatment and immobilization technologies. Applying one or more supplemental treatment technology to the LAW has several advantages, including providing additional processing capacity, reducing the planned loading on the WTP, and reducing the need for double-shell tank space for interim storage of LAW.

This paper describes the testing and pre-conceptual design work that was carried out in 2003 to evaluate one of the potential supplemental treatment technologies, Bulk Vitrification. AMEC's Bulk Vitrification process is based on AMEC's In-Container Vitrification™ (ICV) process. The process involves batch melting in a disposable, refractory-lined steel container. The work established Bulk Vitrification as a leading supplemental treatment technology candidate because it represents a cost-effective solution to accelerate cleanup without sacrificing the environmental advantages of a glass waste form. This paper summarizes the approach taken and the corresponding results. The current status of the Bulk Vitrification process within the Supplemental Technology Program is also described.

INTRODUCTION

The Hanford Site, located in southeastern Washington State, has been a U.S. government installation since 1943. The Site has served national needs first as part of the Manhattan Project and later in the Cold War era. Today, the U.S. Department of Energy (DOE) is responsible for the site, and its mission is environmental cleanup. Within DOE, the Office of River Protection is charged with retrieving radioactive waste from the Hanford tanks and treating it for its eventual disposal.

CH2M HILL Hanford Group, Inc., is the Office of River Protection's prime contractor and is responsible for storing and retrieving more than 200 million liters (53 million gal.) of highly radioactive and hazardous waste. This waste resulted from nuclear fuel reprocessing and is currently stored at 18 tank farm locations in 177 underground tanks: 149 single-shell (see Figure 1) and 28 double-shell tanks.

Fig. 1 One of Hanford's single-shell tanks during construction

Current plans call for the tank waste to be retrieved from the aging tanks and partitioned to separate the highly radioactive constituents from the large volumes of chemical waste. These highly radioactive components will be vitrified into glass logs in the Waste Treatment Plant (WTP), temporarily stored on the Hanford Site, and ultimately disposed of as high-level waste in the offsite national repository. The less radioactive chemical waste, referred to as low-activity waste (LAW), is also planned to be vitrified and then disposed of in approved onsite trenches.

In 1989, the Washington State Department of Ecology, the U.S. Environmental Protection Agency, and DOE entered into an agreement (known as the Tri-Party Agreement [TPA]) to ensure that federal regulations concerning Hanford Site cleanup were followed. The TPA milestones for completing the pretreatment and immobilization of Hanford tank waste are scheduled for completion by December 31, 2028.

To help ensure that these milestones will be met, the Supplemental Treatment Project was undertaken. The project, managed by CH2M HILL, involves the testing, evaluation, design, and deployment of supplemental LAW treatment and immobilization technologies. Applying one or more supplemental treatment technology to the LAW has several advantages, including providing additional processing capacity, reducing the planned loading on the WTP, and reducing the need for double-shell tank space for interim storage of LAW.

In mid-2002, CH2M HILL sponsored a workshop to evaluate technology options that would both enhance and supplement WTP capacity. These technologies are the products of prior work commissioned by DOE over the past decade or technologies developed by private industry. Three LAW treatment options were selected for additional testing and study:

- Bulk Vitrification
- Containerized grout
- Steam reforming.

AMEC's Bulk Vitrification process was one of the technologies selected for evaluation. The Bulk Vitrification process is based on AMEC's In-Container Vitrification™ (ICV) process. The process involves batch melting in a disposable, refractory-lined steel container.

For this project, AMEC was contracted to CH2MHILL to carry-out process development tests and to develop a pre-conceptual design of a production Bulk Vitrification facility. AMEC staff have significant experience in implementing batch vitrification processes in the US, Australia and Japan. To carry out the project, AMEC assembled a team of experts in waste management, research, and design to complement their own staff. The primary team members and their roles are listed below:

- Battelle-Pacific Northwest Division, a leader in contract research and development and a Hanford contractor responsible for operating DOE's Pacific Northwest National Laboratory (PNNL)

- DMJM Technology, a leader in designing advanced technology facilities worldwide, ranging from private sector research, development, and manufacture to public sector defense and space exploration programs

- RWE NUKEM, a leader in nuclear engineering, waste management, and decommissioning services.

BULK VITRIFICATION TECHNOLOGY DESCRIPTION

Bulk Vitrification is a robust, yet simple treatment technology that results in a glass product with exceptional durability, superior leach resistance, high waste loading, and significant waste volume reduction. This technology has been commercially proven by AMEC.

Bulk Vitrification involves the batch melting of waste in a refractory-lined steel container. The type and size of container used for the process can range from a 200-liter (55-gal) drum to commercial roll-off boxes. Electric power is delivered to one or two pairs of electrodes installed in the container. The waste mixture is melted via Joule heating within the waste matrix. When the batch of waste in the container is melted, power is discontinued and the molten material is allowed to cool and solidify within the container. The container and the vitrified waste within it are then transported to a disposal site. With this approach, the container serves as a single-use, disposable melter vessel.

In its simplest form, the container and liner are used only once and are disposed of with each batch of vitrified product. However, in some ICV applications, the container has been designed to be re-usable. In these applications, the container can be disassembled, the vitrified block removed for disposal and the container reassembled with a new liner. Because the liner system is used only once, it is highly reliable because it is not degraded from sustained, long-term use.

Organic contaminants contained in the soil/waste matrix are either destroyed in place by pyrolysis or dechlorination reactions, or processed in the off-gas treatment system (OGTS). Typically 90 to 99.9% of the organic contaminants are destroyed directly by the developing melt pool. Any residual organics released from the treatment zone to the off-gas are collected and treated by the OGTS. The net destruction and removal efficiency (DRE) for the ICV process is typically greater than 99.9999% for organic compounds. No organic contaminants remain in the vitrified product because of the inability of such compounds to exist in such an extremely hot environment for sustained periods (hours to days). Non-volatile and semi-volatile inorganics are remediated with similar results.

Most metals and radionuclides are retained in the melt, with typical retention efficiencies (REs) of four nine's or better (i.e., 99.99%) for the non-volatile species. Semi-volatile heavy metals (e.g., cesium) have been processed by AMEC in other vitrification configurations resulting in REs of 99 to 99.99% for just the melting portion of the process. The remaining residuals released to the off-gas stream are filtered and/or scrubbed from the off-gas.

Off-gas treatment steps vary depending on the waste being treated and the particular regulatory requirements. Typically, the off-gas treatment system consists of an initial stage of particulate filtration, followed by multiple stages of wet scrubbing and two stages of high efficiency particulate air filtration.

Bulk Vitrification is effective in treating a broad range of waste debris including rocks, wood, plastic, concrete and steel. The process can accommodate large items of debris with minimal or no size reduction. Organic-based waste materials such as wood and plastic and inorganic compounds are decomposed by the process. Metallic wastes such as scrap steel drop to the bottom of the melt pool during processing because the density of steel is greater than that of the molten glass. These metallic wastes are either melted or encased in the vitrified product.

Secondary wastes such as spent filters and used protective clothing that are generated as a result of the Bulk Vitrification facility operations can be dealt with by adding them to subsequent batches of waste. The process has been used successfully to treat wastes such as spent filters and used protective clothing. The ability of the Bulk Vitrification process to treat its own secondary wastes is a significant benefit because it minimizes the amount of wastes requiring other treatment or disposal.

The vitrified product normally consists of a mixture of glass and crystalline materials and often has an appearance similar to volcanic obsidian. The composition of the vitrified product is relatively uniform even for cases when melting heterogeneous wastes. The relative uniformity is due to convective mixing currents that exist in Joule heated melts. The vitrified product is typically five to ten times stronger than un-reinforced concrete and is extremely leach resistant. The vitrified product readily satisfies the requirements of the US Environmental Protection Agency's (EPA) Toxicity Characteristic Leaching Procedure (TCLP). The vitrified waste will be effectively inert and can be designed to surpass the most stringent of waste acceptance criteria.

TREATMENT APPROACH FOR HANFORD LAW

The LAW will be retrieved from the Hanford tanks as a liquid and pre-treated to remove solids. For the treatment by the Bulk Vitrification process, the LAW will be mixed with soil and the mixture dried. Additives, such as zirconia (ZrO_2) and boria, (Br_2O_3), may be included with the soil to enhance the durability response of the resulting glass. The need for such additives is dependent on the type of soil being used. Soils, which have negligible concentrations of aluminum and iron oxides, will not likely require the use of such additives.

The refractory lined containers will be readied to receive the dried waste mixture. The preparation steps include installing electrodes and fitting an off-gas collection hood to the top of the container. The dried mixture is then deposited within the container through fill ports installed in the hood.

Treatment then commences with the passage of electrical current between the electrodes through the waste mixture. When the volume of waste mixture has been melted, the electrical power to the melt is turned off and the molten waste is allowed to cool and solidify. During the cooling process, the void space within the container is back-filled with soil. Soil is added through fill ports in the hood.

The off-gas collection hood, which is installed prior to the receipt of the dried waste mixture, also serves as a lid for the container. Consequently, once installed, the hood is not removed and is disposed of after each use with the container of vitrified waste.

The refractory liner system installed on the sides and bottom of the container and the soil that is back-filled in the container after treatment reduces the radiological contact dose rate on the exterior of the container. The liner and fill soil reduce the dose rate by a factor of 10 or more, which reduces the exposure potential for workers.

PROJECT APPROACH

The primary objective of this project was to demonstrate the feasibility of Bulk Vitrification as a supplemental treatment technology for Hanford's LAW. To meet this objective, a project was defined that included two primary tasks: process development testing and pre-conceptual design.

The process development testing task included four primary activities:

- Glass formulation and laboratory testing with simulated and actual LAW
- Small-scale Bulk Vitrification tests with simulated LAW and Tc-99
- Full-scale Bulk Vitrification tests with simulated LAW
- Small- and pilot-scale concentrate dryer tests with simulated LAW.

In these tasks, PNNL formulated the glass composition and tested the resulting glass. AMEC conducted both the small- and full-scale tests.

GLASS FORMULATION

PNNL prepared a series of 16 preliminary glass compositions to determine the most suitable waste glass formulation; that is, the one that would be the most durable, be the most leach resistant, have the highest possible waste loading, and meet Hanford burial facility requirements. All glasses were subjected to two cooling regimes, quenched and slow cooled, to simulate the expected thermal treatment that the cooling glass may experience in the full-scale container. The quenched glasses were removed from the oven and allowed to immediately cool. The slow cooled glasses were taken from process temperature (~1300 C) to solidification (~500 C) over the course of about 1 week. The 1-week period was based on a calculation of the estimated cooling rate for the glass in the center of the container. Typically, the slower the glass cools, the greater the chance for crystalline phases to form. Although the presence of crystals in the glass is not expected to have a detrimental effect on the durability of the glass product, it is prudent to be aware of their presence and composition.

PNNL tested the durability and leach resistance of the quenched and slow cooled products of each of the 16 preliminary glasses using the following standard procedures:

- vapor hydration test (VHT)
- product consistency test (PCT)
- toxicity characteristic leach procedure (TCLP).

In addition, PNNL also determined other glass properties of interest including viscosity, electrical conductivity, density, and identification of crystalline phases using scanning electron microscopy and x-ray diffraction.

In the VHT, glass samples are exposed to water vapor at 200°C in a sealed vessel (see Figure 2), which greatly accelerates the progression of corrosion. After 7-day intervals (typically conducted at 14 and 28 days on this project), samples are removed and divided in two to measure the extent of corrosion and for analysis by optical microscopy with image analysis to determine the effects of the corrosion.

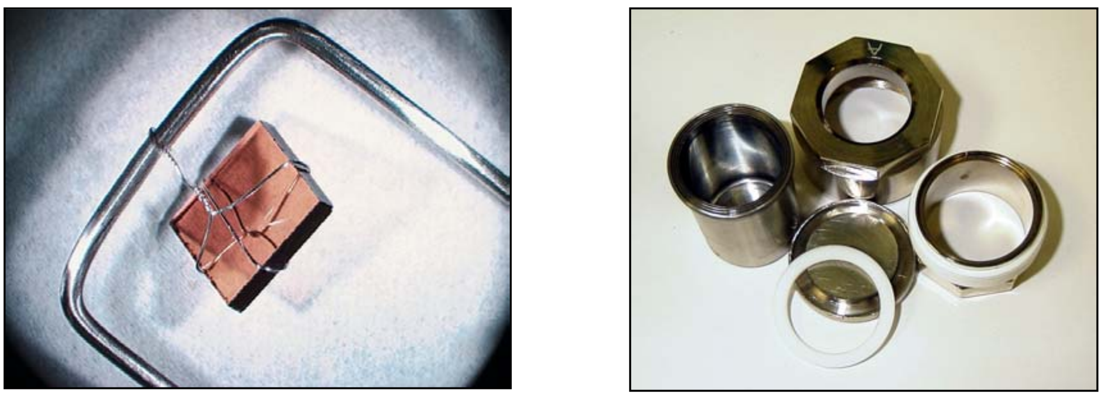


Fig. 2 Glass coupon (left) and test vessel (right) for vapor hydration testing.

The PCT is used to assess chemical durability. Glass samples are ground, washed, and prepared according to the ASTM procedure; water is added; and the vessel is sealed and placed in an oven at ~90°C for 7 days [1]. The vessel is removed from the oven and allowed to cool to room temperature. Test solutions and blanks are then analyzed for silicon, sodium, and selected other components. Concentrations of aluminum, silicon, sodium, boron (if present), lithium (if present), and calcium are determined by inductively coupled plasma-atomic emission spectroscopy (ICP-AES). The concentrations of technetium and cesium are determined by beta counting and gamma energy analyses, respectively. The concentration of sulfur is determined by ion chromatography (IC). Results are compared with established limits.

The TCLP is a test to assess the leachability of toxic elements from hazardous wastes that are destined for a land disposal facility. In this test, relatively large (3/8" minus) pieces of glass are placed in dilute acetic acid and agitated at ~30 rpm for ~20 hours at room temperature. The concentrations of hazardous metals in solution are then measured and compared with established values.

Based on the results of these tests, one glass formulation (known as AMBG-13) was determined to be the most suitable and selected as the baseline composition. Its composition is shown in Table I. Using this formulation, PNNL then conducted five crucible melts using simulated waste and two crucible melts using actual LAW. In the five crucible tests, the waste loading was varied from 17-wt% to 24-wt% Na_2O. These tests were designed to evaluate repeatability and waste loading limits.

Glass Formulation Results

In the VHT, the most stringent test for these glasses, the AMBG-13 glass (and two of the other 16 candidate glasses) had very low corrosion rates, as illustrated in Figure 3. This result suggests that these glasses are more durable than the LAW-ABP-1 glass used in the 2001 performance assessment evaluating the performance of vitrified low activity waste for the Waste Treatment Plant [2]. A cross-section of the AMBG-13 glass coupon following VHT exposure is provided in Figure 4 in contrast with LAW-ABP-1 glass.

In the PCT, 15 of the 16 glasses passed the PCT requirements by approximately an order of magnitude.

Regarding phase identification, no crystals were apparent in AMBG-13, either quenched or slow cooled. Two other glasses (AMBG-14 and -16) performed slightly better than AMBG-13 relative to VHT requirements; however, the other two glasses contained a secondary crystalline phase. Although such a phase can be acceptable, the decision was made to use the AMBG-13 formulation.

Table I AMBG-13 glass composition

Component	**Weight %**
Soil	68.2
Waste	19.8
ZrO_2	7.0
B_2O_3	5.0
Oxide	**Weight %**
SiO_2	42.6
Na_2O	20.0
Al_2O_3	9.9
ZrO_2	7.0
Fe_2O_3	6.3
B_2O_3	5.0
CaO	3.8
K_2O	1.8
MgO	1.0
TiO_2	1.0
SO_3	0.8
Total	**99.1**

The other key properties of the AMBG glasses, including viscosity, conductivity, density, and TCLP response, have been measured. The values for these properties in all AMBG glasses are well within acceptable ranges. AMBG-13 passed TCLP requirements by approximately an order of magnitude.

In the five crucible tests with simulated waste, the AMBG-13 glass performed well up to 22-wt% Na_2O in the glass. The VHT results as a function of Na_2O waste loading are illustrated in Figure 5. VHT results indicate that increased waste loading up to 22 or 23-wt% Na_2O in the AMBG-13 glass is possible.

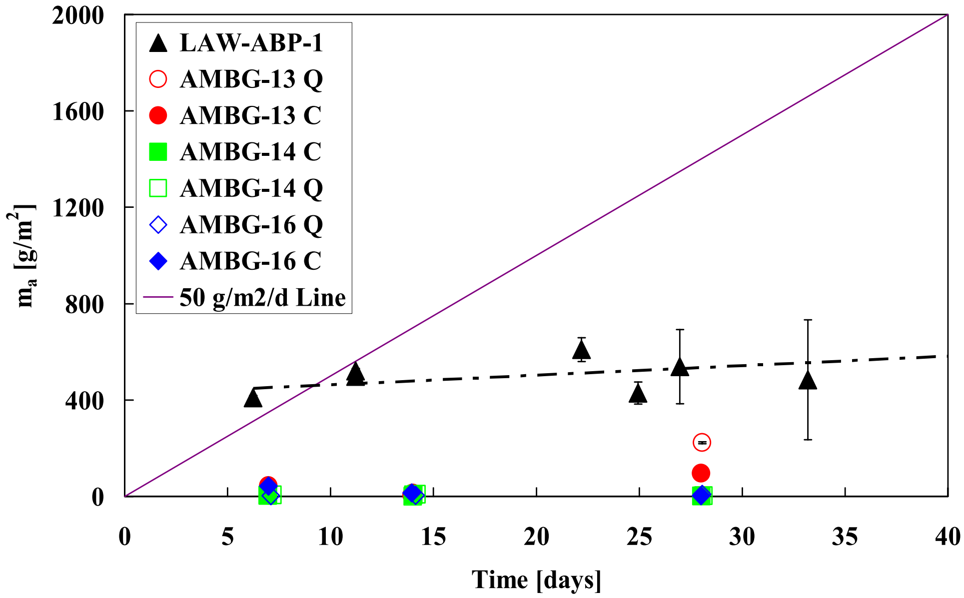
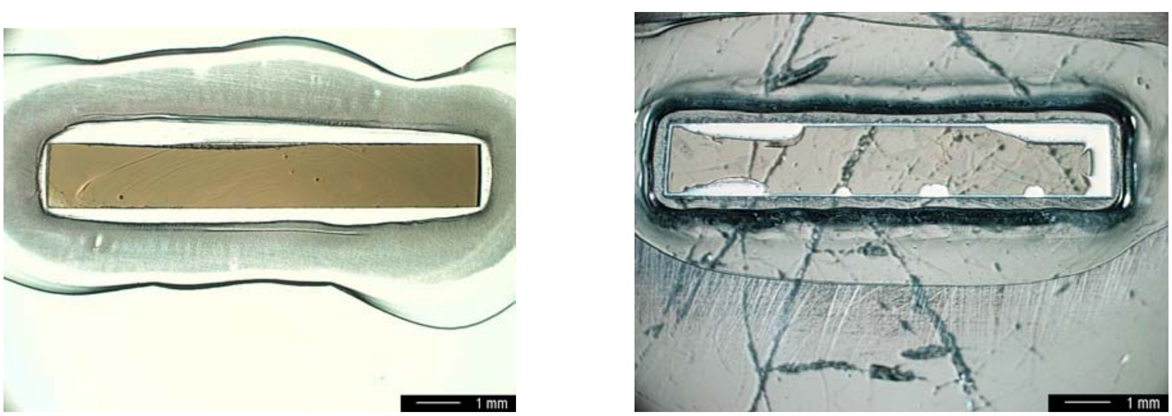


Fig. 3. VHT results for three Bulk Vitrification glasses (Q = Quenched and C = Slow Cooled) including AMBG-13 illustrate the low corrosion rate compared with LAW-ABP-



AMBG-13, 14 days LAW-ABP-1, 11 days

Fig. 4. VHT cross-sections of AMBG-13, which shows no apparent corrosion, compared with WTP LAW glass formulation LAW-ABP-1.

In addition, the AMBG-13 glass does not approach the PCT limit of 2 g/m^2 even at 24-wt% Na_2O as shown in Figure 6.

In the two radioactive crucible melts using actual LAW, the AMBG-13 glass was subjected to the same types of tests and evaluations as conducted in the melts with the simulated waste. The glass sample showed virtually no reaction in the 14-day VHT.

It should be noted that while the AMBG-13 formulation appears to produce an excellent glass product, no effort has been made in this project to optimize the formulation. It is believed that with additional research and testing, the formulation could be optimized for further cost effectiveness and higher waste loading.

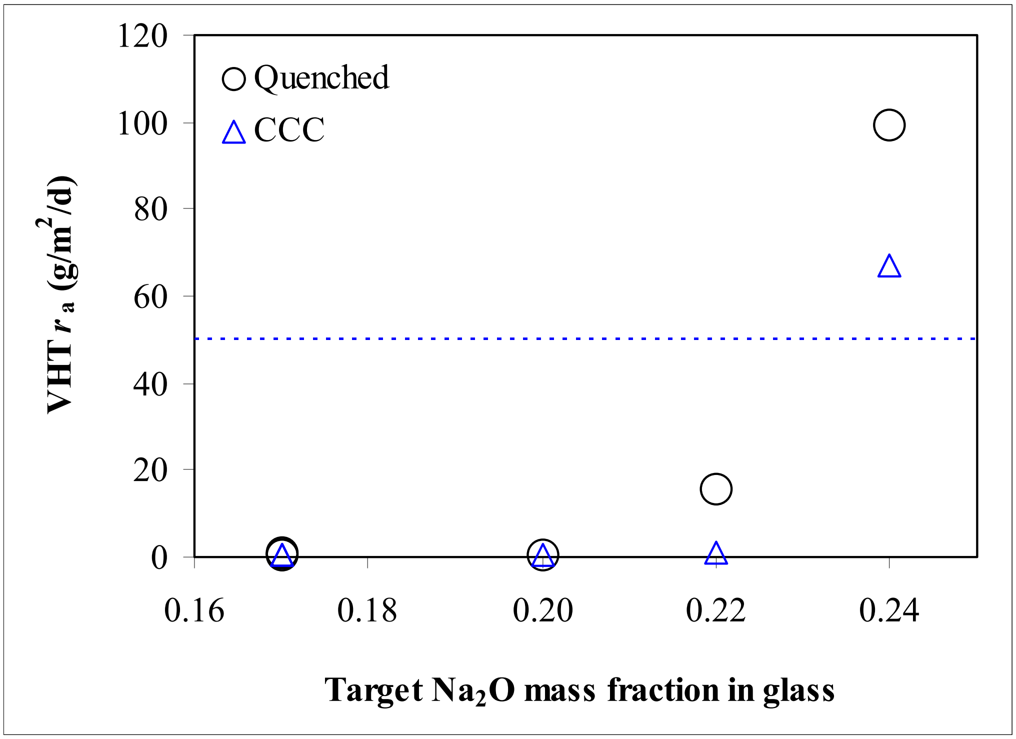


Fig. 5. VHT results as a function of waste loading show that waste loadings above 20-wt% Na_2O are possible. The limit of 50 g/m^2/day is illustrated by the dashed line in the Figure.

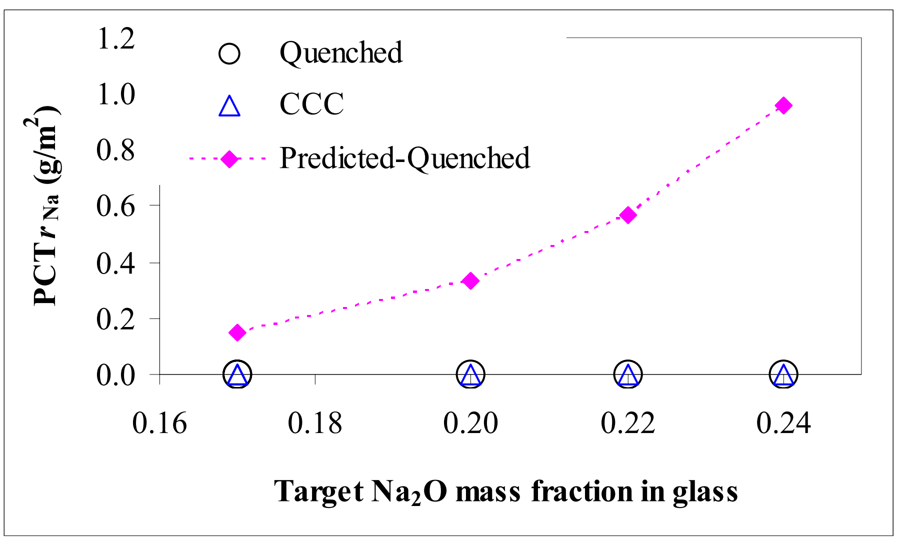


Fig. 6. AMBG-13 glass performed exceptionally well in the PCT and did not approach the 2-g/m^2 limit.

SMALL-SCALE BULK VITRIFICATION TESTS

AMEC staff, with the assistance of PNNL staff, conducted two small-scale Bulk Vitrification tests, each using ~2.83E4 cm^3 (1-ft^3) of simulated waste mixed with Hanford soil, using the AMBG-13 formulation. In the first test, rhenium was added to the mixture as a potential surrogate for technetium, which has no non-radioactive isotope. In the second test, rhenium and ~1 mg of Tc-99 were added to the simulated waste mixture to determine how effectively technetium would be immobilized in the resulting glass. Technetium is a radionuclide of concern for LAW because of its toxicity and its mobility. Thus, the ability of the selected supplemental technology to effectively immobilize technetium is a critical consideration.

During each test, operational parameters, including off-gas emissions, were closely monitored and over 60 samples of the glass, off-gases, and surrounding soil were collected. After the tests, samples of the vitrified glass, off-gases, and other media (filters, surrounding sand, etc.) were analyzed.

Small-Scale Bulk Vitrification Test Results

Both small-scale tests were completed successfully. In both tests, the equipment operated smoothly with no difficulties. The typical power level for both tests was ~12 kW. The duration of the first test was ~8.5 h; the second test lasted ~6 h. The maximum melt temperature measured for both tests exceeded 1300°C. The melt temperature in the second test was slightly higher than the first test (~1360°C). The 14-day VHT showed no reaction in any sample, establishing that the resulting glass is exceptionally durable. Approximately 93% of the technetium was retained and immobilized within the glass block. Although this 93% retention value is very good, trace amounts of technetium in the form of soluble salts were detected within the waste package outside of the vitrified product. Further work is being planned to investigate methods to improve the performance relative to technetium. Results also showed that only about 79% of the rhenium was retained in the glass block on the same test. This shows that if rhenium is to be used as a surrogate, it provides a very conservative result relative to technetium volatility.

FULL-SCALE BULK VITRIFICATION TESTS

AMEC conducted three full-scale Bulk Vitrification tests using simulated waste mixed with Hanford soil and additives. In the three tests, the target waste loading was varied from 12.5-wt% Na_2O in the glass for the first test, 17-wt% for the second, and 20-wt% for the third. AMEC's full-scale commercial vitrification equipment was used for these tests. The melt containers were 28-m^3 (37-yd^3) roll-off boxes (see Figure 7).

Off-gases resulting from the vitrification process were treated by a series of treatment steps in the following order:

- The particulate in the off-gas stream was filtered with a bag house filter system
- The off-gas was then routed through a single stage of high efficiency particulate air filtration to remove any residual particulates
- The off-gas was then quenched in the first stage of a wet-scrubbing system
- NO_x was removed from the gas stream via a packed column scrubber
- Finally, the off-gas was then heated and subjected to two final stages of HEPA filtration before being exhausted to the atmosphere.

Fig. 7. Photograph of a 28-m^3 (37-yd^3) melt container and off-gas hood assembly during a full-scale Bulk Vitrification test.

During the tests, operational parameters, including off-gas emissions were closely monitored. After the tests, samples of the vitrified glass were analyzed to determine durability, leach resistance, and other qualities. Samples of the off-gases collected during operations at the hood exit prior to any off-gas treatment were analyzed to characterize the emissions from the melting process. Samples of the off-gases at the exit of the treatment system were analyzed to confirm compliance with regulatory requirements.

Full-Scale Bulk Vitrification Test Results

All three tests were conducted successfully. In each case, the refractory liner system performed well. The maximum temperature measured on the outside surface of the box was only 70°C, which is well within design limits. The melt temperature was typically on the order of 1300°C.

The average power used for melting was varied in all three tests. The average power level was 200 kW in the first test, 400 kW in the second and 300 kW in the third. The durations of the three tests were typically on the order of 48 to 55 h, which was shorter than expected. About 13 metric tonnes of simulated waste material was treated in each test. Treated off-gas emissions readily satisfied air emissions permit limits that were established for the test. NO_x concentrations in the treated off-gases were typically about an order of magnitude below the permit limit of 908 g/h (2 lbs/h). SO_2 emissions in the treated off-gases were treated to several orders of magnitude below permit limits to very low concentrations (typically <10 ppm).

The glass waste form resulting from the tests easily satisfied performance requirements. The durability responses were very similar to that determined in the laboratory and small-scale tests.

DRYER TESTING

To support the design work, small- and pilot-scale concentrate dryer testing with simulated LAW was conducted to confirm the feasibility of drying the simulated liquid LAW while mixing it with Hanford soil. The dryer produced a flowable, granular material with a moisture content of ~2%. The results indicate that the dryer works well to dry the liquid waste and produce a suitable powder material.

PRECONCEPTUAL DESIGN TASK

The objective of the design task was to develop technical and engineering data (including facility layout drawings, process and instrument diagrams, process flow diagrams, and electrical schematics) for the pre-conceptual design of a production Bulk Vitrification plant.

Prior to award of this work, CH2M HILL worked closely with the Office of River Protection to develop the overall design strategy for using supplemental treatment technologies. They defined the technical basis for key design parameters that supported DOE's obligations to remediate the tank wastes (e.g., TPA milestones). The primary resulting criterion was to design a facility that could treat 37.8-L/min. (10 gal/min) of pretreated LAW, operating continuously.

Throughout the design process, AMEC's team and CH2M HILL staff worked together to refine the design approach, resulting in a design that has modular components and is expandable – attributes that enhance the flexibility of the facility to meet future changing needs. In addition, AMEC was able to develop the design in parallel with the process development testing, using data from the testing as it became available.

Design Results

The design team determined that six Bulk Vitrification containers needed to be processed simultaneously to meet the target treatment rate. They also determined that optimum operations could be achieved with two separate but identical plants (one in the 200 East area and one in 200 West), each with three process lines. The two plants eliminate the complexities and risks associated with cross-site transfer of wastes.

Several features were incorporated in the design to minimize radioactive exposure to operating staff. These features include locating the Bulk Vitrification containers below ground level in trenches, maximizing the distance and remoteness of operations from processing activities, and taking advantage of the inherent shielding of the container liner.

A study was conducted to evaluate the radiological dose on contact for melt container at three cesium concentrations. The base design was found to be able to accommodate cesium concentrations in the LAW feed up to 0.003 Ci/L and still satisfy contact handled constraints. With further enhancements to the design, a 10-fold increase in the cesium loading could be accommodated.

CONCLUSIONS

Key outcomes from the process development testing task include the following:

- The AMBG-13 glass formulation provides excellent durability and leach resistance based on VHT and PCT procedures, using Hanford soil as the primary source for glass formers.
- Waste loading in excess of 20-wt% Na_20 is possible based on the AMBG-13 formulation.

- The small-scale test with technetium-99 established that the majority (approximately 93%) is retained and immobilized in the glass
- The full-scale testing with simulated LAW was successful producing a glass waste form of exceptional durability and satisfying off-gas emissions requirements.
- The dryer testing with simulated LAW demonstrated that a flowable, granular product was produced with a very low moisture content that is suitable for Bulk Vitrification treatment.

Key outcomes from the design task include the following:

- A design was developed that involves two identical plants, one located in the 200 East area and one in 200 West area
- The design for each plant includes three process lines (three containers treated in parallel) to meet the 37.8-L/min. (10-gal/min) treatment requirement.
- Dose rate calculations establish that the inherent shielding associated with the lining of the Bulk Vitrification container will significantly minimize radiation exposure to personnel.

The value and simplicity of the Bulk Vitrification process, the quality of the resulting glass product, and the testing and design results of this project to date all support the selection of Bulk Vitrification for the Supplemental Treatment mission.

Plans are currently being developed for a full-scale Bulk Vitrification test and demonstration project at the Hanford site. The demonstration project would involve the treatment of actual LAW. The project would provide the opportunity to evaluate the ability of the Bulk Vitrification process to treat LAW at a scale commensurate with a production plant.

ACKNOWLEDGEMENTS

AMEC acknowledges CH2MHILL Hanford Group, Inc. and the DOE Office of River Protection for the programmatic direction and funding provided to carryout the work.

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FOOTNOTE

In-Container Vitrification™ (ICV) is a trademark of AMEC Inc.