IN SITU STABILIZATION OF MIXED RADIOACTIVE WASTE STORAGE TANKS AND CONTAMINATED SOIL AREAS

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INTRODUCTION

The many years our nation spent in various military and defense activities has left a Cold War legacy of complex environmental problems. Almost as much effort has gone into developing advanced technologies to deal with these problems as was expended to cause the problems in the first place. The result has been that many environmental cleanup problems involve complex and costly solutions. The overall expense of these cleanup efforts has in many cases actually delayed or prevented cleanup actions from occurring. For this reason it is important to look for less expensive, practical, and effective solutions wherever possible.

Two problems which historically have involved expensive solutions mixed radioactive waste storage tanks and subsurface soil areas which contain contamination and debris. Baseline technologies for dealing with these problems have typically involved excavation and treatment of the contaminated materials. These are expensive, difficult, and often relatively ineffective solutions to these problems.

For these reasons scientists at the Idaho National Engineering and Environmental Laboratory (INEEL) have investigated alternative solutions to the waste tank and contaminated subsurface soil problems. These studies led to the conclusion that existing technologies can be used for in situ stabilization of these contaminated items at much lower cost than conventional excavation and treatment processes. This can be done with improved safety for the workers and the environment.

This paper will discuss testing that has been done at the INEEL on both underground waste tank and subsurface soil area in situ stabilization technologies.

MIXED RADIOACTIVE WASTE TANK STABILIZATION

Problem:
Most nuclear facilities generate some type of liquid wastes. These typically contain a variety or radioactive isotopes but usually also contain a variety of chemicals, heavy metals, organic, and even PCB's. These latter materials, when combined with the radioactive components, result in the tank contents being declared a mixed radioactive waste. From a regulatory standpoint these mixed waste materials are much more difficult to handle, treat, and dispose of than are purely low level radioactive wastes. This always complicates, and sometimes even prevents the removal and disposal of these tank contents.

This situation is often further complicated by the fact that these tanks are often buried underground in difficult to access places. They are usually old and of unknown, but highly suspect, integrity. They almost always contain "surprises" in contents, location, structure, or accessability. The unknown nature of these tanks and their contents make them very difficult to handle in conventional ways. These tanks are sometimes located in places, such as beneath operating facilities, or within previously stabilized areas, where it is not practical to remove them at the current time.

However, it is also usually not acceptable to ignore them or put off dealing with these tanks and their contents. To continue to ignore them often results in eventual leaks and thus even greater problems. Until a final solution can be found and agreed on these tanks should be stabilized so that environmental problems do not result.

Solution:
A collection of proven technologies is available to deal with these types of mixed radioactive waste storage tanks. The selection and use of the proper technologies will permit inspection, characterization, stabilization, and monitoring of such difficult to deal with tanks. By properly selecting the proper available technologies the contents of these tanks can be characterized and stabilized in place to prevent the potential of leaks and other environmental problems. The tank and its contents can then usually be removed intact if desired, or it can be left indefinitely without further concern about it leaking or of contamination spread. In situ stabilization of the contents of these tanks is much less expensive than conventional pump and treat approaches. This is especially true when the contents are subject to regulatory restrictions which make them essentially impossible to deal with in conventional ways.

INEEL Tank V9:
An example of the types of problems which can be encountered with these mixed radioactive waste storage tanks is demonstrated by the V9 Tank at the INEEL. This 400 gallon tank is nearly full of a highly contaminated sludge/liquid mixture containing a wide variety of radioactive isotopes, heavy metals, organics, and PCB's. The only practical access to the tank is through a six inch diameter pipe which penetrates the top center of the tank. The top of the tank is located approximately seven feet below grade in an area of radioactively contaminated soil and other highly contaminated waste tanks. The tank is 44 years old and of unknown integrity. It had not been completely isolated from other liquid waste transfer lines in the area. In addition to the liquid and sludge, the tank contains various types of debris including rocks, tree leaves, paper, and wire or metal sheathed cable. Because there are many regulatory issues associated with this tank and the surrounding area removal or treatment of the tank contents may take a considerable amount of time. Because of the age and unknown integrity of the tank it is desirable to stabilize its contents while awaiting a decision on its final disposition. A schematic diagram of the V9 Tank is shown in Figure 1.

A program was thus developed to perform an in situ stabilization of the V9 Tank contents. This program involved isolating the tank from other systems, inspecting it, characterizing its contents, selecting an appropriate stabilization material and technique, and then performing the actual stabilization of the V9 tank. As part of this program it was planned to demonstrate the performance of the set of technologies used on a full sized mockup of the V9 Tank. These demonstration or mockup tests were performed using non contaminated materials in a "cold" or non contaminated area designated for this type of testing. These demonstration tests were conducted in the INEEL Cold Test Pit (CTP).

Cold Test Pit Demonstrations:
Following inspection by remote video camera, and characterization by making direct radiation field readings and by collecting samples for laboratory analysis, a V9 Tank mockup was designed.

Actual V9 Tank drawings were used to construct a mockup tank (including its chordal baffle) of the same size and shape as the original. Laboratory testing was conducted to simulate the sludge/water mixture, and provisions were made to install the mockup tanks at a seven foot depth in the INEEL CTP. Five mockup tanks were fabricated to accommodate a range of test conditions and stabilization materials. The mockup tank experiment including the stirring mechanism is depicted in Figure 2.

Laboratory tests were conducted to help with the selection of an appropriate stabilization or solidification agent. A mixture of the commercial solidification material Aquaset IIH and Portland cement was selected as an appropriate agent for use with the V9 Tank wastes. Tests were conducted using only Aquaset IIH and with Aquaset IIH/Portland Cement mixtures ranging up to approximately equal parts of the two materials. Small amounts of Cerium were added to the tank to serve as a tracer material to be used in evaluating the extent of mixing in various parts of the tank.

Laboratory and mockup field tests were also conducted to determine the most suitable mixing process to be used to introduce the stabilization materials to the tank. For this particular tank geometry it was determined that a stirring mechanism consisting of a variable speed motor driven shaft having straight impellers or blades was the most economical and efficient mixing mechanism. Stirring action can be seen in Figure 3 which is a photograph of the top of the contents of a mockup tank during one of the demonstration tests.

Following the appropriate laboratory tests, field preparations, safety and operations documentation preparation, and personnel training a series of four mockup tests were conducted at the CTP. These tests were conducted using various Aquaset-to-cement ration, stirring speeds and times, etc. At the conclusion of the stirring operations Thermistors were inserted at various locations within the mixed material and their output monitored to observe curing time. After the temperatures had stabilized indicating completion of curing the tank was removed from the test pit and allowed to continue curing above ground for a few days. The top of a stabilized mockup tank showing the Thermistor leads is shown in Figure 4. Cores were then obtained from various locations within the stabilized tank material. These were then analyzed for strength and Cerium tracer distribution in a laboratory. Typical cores obtained from the stabilized tank material are shown in Figure 5.

Several conclusions can be drawn from the results of these mockup tests.

(1) The concept of tank mixing, coupled with dry feed addition, is an effective technology in stabilizing the contents of small tanks such as this. Thorough and complete mixing was attained, even behind the large chordal baffle which this tank contained.

(2) Thermistor data is of little value in monitoring mixing variations (because mixing was very uniform), but is useful in indicating when curing of the mixed material is complete.

(3) Although stabilization of the tank contents using only Aquaset IIH produced adequate solidification compressive strength tests of the core samples was relatively weak. The

addition of increasing amounts of Portland cement significantly increased the strength of the core samples. Portland cement in amounts approaching 50% provides an much more solid stabilized material.

(4) A stirring shaft guide and at least five impellers are necessary to effect complete and efficient mixing in tanks such as these. A photograph of the stirring shaft used in these tests is shown in Figure 6.

(5) Adequate technology exists to remotely inspect, characterize, and stabilize a variety of underground mixed waste storage tanks. This can be done at much less expense, in a safer manner, and in less time than is required for conventional removal and treatment technologies require. Stabilization of these materials represents a suitable alternative to conventional processes

CONTAMINATED SUBSURFACE SOIL AREAS

Problem:
Many contaminated subsurface soil areas exist throughout the country. These areas became contaminated in many ways and with a wide variety of contaminants. Within the US Department of Energy complex many of these areas are contaminated with radioactive isotopes. In some cases only the soil is contaminated, while in others structures, equipment and debris of all sorts have also been buried in the areas thus creating further problems. Organics, chemicals, and heavy metals are often also included in the contamination making the area a mixed radioactive waste site. Conventional methods of dealing with these subsurface contaminated sites, i.e. retrieve and treat, is often very difficult and not practical based on the nature of the contaminants or the location of the contaminated site.

Left untreated however these sites can create a number of problems. These include subsidence, migration of contaminants, airborne contamination when retrieval is attempted, and public perception problems if nothing is done with the site. Solutions to all of these problems are available through
innovative in situ stabilization technologies.

Solution:
Investigation of innovative in situ stabilization technologies for use at subsurface contamination sites have been investigated at the INEEL for the past several years. Tests have been conducted in various simulated burial sites and a variety of in situ stabilization techniques and materials have been tested. The results of these tests have been reported in a final report for the project (Reference 1). Experience gained at these simulated waste sites at the INEEL CTP, indicate that the process is ideally suited for actual waste disposal areas at the INEEL. High pressure jet grouting could be used to stabilize waste sites thus eliminating the possibility of subsidence occurring later or migration of the contaminants from the site. If at a later time a decision is made to retrieve the stabilized material airborne
contamination problems would be minimized.

INEEL Acid Pit:
This waste disposal area is located within the INEEL Radioactive Waste Management Complex and was used for the disposal of radioactively contaminated acidic type wastes. Although no solid wastes are known to have been disposed in the pit, record searches indicate that it did receive liquids which included carbon tetrachloride, organic solvents (trichloroethylene, trichloroethane, and tetrachloroethylene), and radiologically contaminated acids. The Acid Pit is surrounded by other inactive, covered pits, and soil vaults. Lime was applied periodically to neutralize the acids disposed in the pit. The Acid Pit was closed in the early 1970's and a three foot layer of soil was placed over it. The Acid Pit covers approximately 20,490 ft^2 (197-ft x 104-ft), and is about 20 ft deep.

The intent is to use injection grouting equipment to stabilize the contaminated soil in the Acid Pit. A grid pattern using staggered 19 inch spacings will be used to determine bore hole placement for the injection grouting stem. The entire Acid Pit area will be grouted in effect making it into a solid grouted monolith.

Cold Test Pit Demonstrations:
As was the case for the tank stabilization work described above, mockup tests will be performed at the CTP prior to applying the technology at the Acid Pit. This will allow the development of the final equipment and procedures, and serve as a demonstration of the integrated technologies and procedures prior to performing these operations on an actual contaminated site. The equipment has been designed and procured, all documentation prepared, and a preparedness review conducted in preparation for performing the demonstration at the CTP.

Following a successful demonstration of the technology and equipment at the CTP, the injection grouting equipment will be moved to the Acid Pit and the stabilization process repeated there. Based on experience gained in previous work of this type (see Reference 1), it is fully expected that both the CTP demonstration tests and the actual Acid Pit stabilization will go well. This will result in a much less expensive solution to the problem of subsurface contaminated soil areas than has been previously used.

CONCLUSIONS

Underground tanks and other structures, and subsurface contaminated soil areas can be stabilized using existing technologies at much less expense than by the use of conventional retrieve and treat techniques. This is much safer for the workers, and much less time is required to stabilize the waste. The process represents a safe, cost effective solution to these problems.

REFERENCES

Guy G. Loomis, et. al., Innovative Subsurface Stabilization Project-Final