Acrylamide Provides Lasting Help for United States Government

Beginning in 1985, federal and state regulatory agencies began close monitoring of the waste management operations at the United States Oak Ridge National Laboratory (ORNL), as well as other Department of Energy (DOE) sites. At ORNL they discovered that remote monitoring wells were registering levels of radioactive and mixed solid wastes which had leaked from numerous waste burial trenches constructed during the active days of the Manhattan Project, 1951. They concluded that the DOE did not have adequate solutions for long-term containment of the waste materials. Therefore, a comprehensive study was undertaken to find a lasting method of radioactive waste containment and environmental protection.

Pilot Program for Grouting Selection

Since the source of the ground and surface water contamination was generally known, Oak Ridge engineers immediately began to evaluate grouting applications and soil stabilization methods to alter the localized soil and reduce permeability of the soil around the waste burial trenches. Seven chemical grout formulations were evaluated for their ability to meet the primary project parameters of hydraulic conductivity reduction and longevity in the treated soil. Three of the grout formulations were suspension grouts which contained particulates: lime-fly ash, fly ash-cement-bentonite, and bentonite. None of the suspension grouts could effectively penetrate the soil formation and were therefore not acceptable as candidates for further evaluation. The solution grouts, containing no suspended solids, included sodium silicate, resorcinol-formaldehyde, acrylate and acrylamide. Each demonstrated good penetration of the soil and reduction of the hydraulic conductivity. Only acrylamide however was able to reduce the conductivity levels from 10^{-4} m/s to less than 10^{-8} m/s. (Exact reduction was unknown because the performance of the acrylamide grout exceeded the measurement capabilities of the monitoring equipment.) For this reason, the acrylamide chemical grout was selected and subjected to the next phase of testing.

Of the seven original grout formulations evaluated only acrylamide reduced the hydraulic conductivity levels below 10^{-8} m/s.

Collar pipe installation at ORNL trench.

Pilot Program - Phase Two

Acrylamide chemical grout had passed the first set of evaluations, but the big question was whether it could perform long-term in the field, especially in such a contaminated environment. Two of the smaller trenches were chosen for field evaluation and injected with the acrylamide chemical grout. Based on previous measurements, it was concluded that "the voids within the trenches were totally filled by the grout and that the intratrench hydraulic conductivity was reduced to below field-measurable values."

"The half-life for acrylamide chemical grout was 362 years."

The grout was also completely contained within the two trenches as no grout constituents were observed in the 12 perimeter groundwater monitoring wells. These results proved that the acrylamide grout had properly cured and stabilized the soil even in the presence of radioactive waste. The stabilized trenches were monitored over several months to determine the degradation rates of the organic acrylamide grout. These rates were established by monitoring the rates of carbon dioxide evolution from amended soils as microorganisms metabolized the grout as a carbon and energy source. Microbiological half-lives were estimated from this

Pilot Program - Phase Two (cont.)

rate of carbon dioxide evolution and from samples returned to the lab for a six-month observation period. Upon the completion of the "carbon-dating" process, the half-life for the undisrupted acrylamide chemical grout was determined to be approximately 362 years. Due to its sucessful field demonstration and superior performance in laboratory degradation studies, the acrylamide chemical grout received final approval for use in immobilization and remediation of buried radioactive waste.

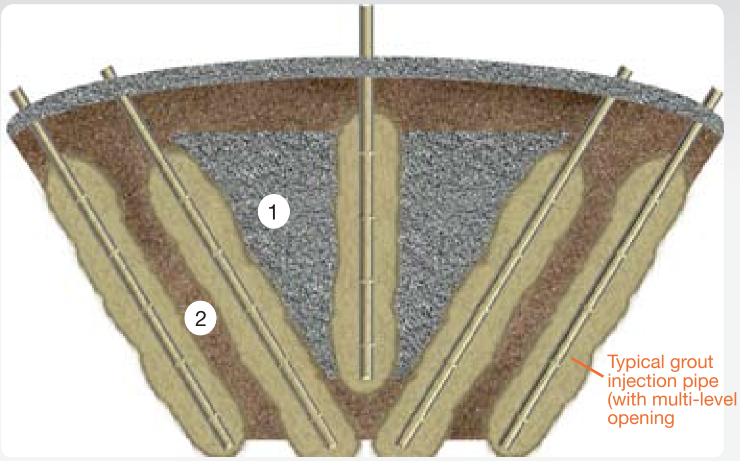
Field Application

Full-scale grouting of the buried radioactive waste trenches began in the summer of 1996 and continued to the end of that year. A reduction in the quantity of radioactive waste leakage was immediately detected at adjacent monitoring wells, and a hydrologic monitoring system was established to determine the overall long-term effectiveness of the project. Fifteen years from the date of the original project, acrylamide chemical grout is still providing in situ isolation of the buried waste.

Performance Summary

At the onset of this project, the DOE required low-level waste disposal applications to have performance lifetimes of approximately 200 years for the isolation of hazardous radionuclides; acrylamide chemical grout was evaluated using these government standards and exceeded the parameters. As a result, acrylamide grout was accepted by the DOE to manage the long-term isolation and storage of radioactive hazardous waste.

Cross-section of grout treatment zones



Grouting Sequence
1) Crushed stone - waste zone
2) Adjacent soil zone (min 3-feet wide)

Radioactive and hazardous waste encapsulation with acrylamide grout was approved by the DOE as a long-term solution.

Reference

Spalding, B. P., S. Y. Lee, C. D. Farmer, L. K. Hyder, and P. Supaokit. 1986. *In Situ Grouting of Buried Transuranic Waste with Polyacrylamide*. Martin Marietta Energy Systems, Inc., U.S. Department of Energy, under contract no. DE-AC05-84OR21400, Publication no. RAP86-69, Environmental Sciences Division Oak Ridge National Laboratory, Oak Ridge, TN 37831.

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