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Session III - Leaching Science

Overview of Research Supported by EPA - Dr. David Kosson

Dr. David Kosson, of Rutgers University, presented an overview of the leaching research that EPA has supported in recent years in his laboratory. He described the current applications of leaching tests, including: waste classification (hazardous vs. non-hazardous), evaluation of treatment process effectiveness, waste management options, and alternative disposal options.

Dr. Kosson stressed the need for a consistent approach for evaluating wastes to determine appropriate waste management practices. Such an approach must reflect the maximum potential release of contaminants from the waste. It must consider the cumulative release over a defined time frame. He noted that the initial leachate composition can be very important, and that it tends to reflect the pore water composition.

Dr. Kosson described an alternative approach to leaching that involves five steps:

1. Define the release mode and the fundamental leaching parameters
2. Design the test method to measure the fundamental parameters
3. Test the waste
4. Calculate the release for a given management scenario
5. Evaluate the acceptability of the release based on the project impact.

He discussed fundamental leaching parameters, which include:

6. Availability of the contaminants
7. Liquid/solid equilibrium (solubility of a constituent may vary as a function of pH or of the L/S ratio)
8. Release rates (release rates can be different from monolithic wastes vs. compacted granules)
9. Acid/base neutralization capacity

Dr. Kosson discussed the problems of particle size and contact time, noting that consideration must be given to the particle size distribution of the actual waste, the potential for the coupled release of contaminants, and the practicality of the test and any particle size reduction techniques.

His current research involves further methods development work for organic constituents, as well as resolving the issues surrounding particle size, equilibrium time, and sample size. Dr. Kosson discussed the need for further development of leaching models.

Dr. Kosson advocated a tiered evaluation framework and the use of a more robust evaluation framework to better facilitate waste management decisions. Tier 1 would look at the availability

of the contaminants in the waste. Tier 2 would evaluate the compliance of the results with the equilibrium concentrations (e.g., does an equilibrium model fit the data?). The Tier 3 evaluation would examine the mass transfer rate.

Dr. Kosson described an example disposal scenario that would employ four sets of parallel extractions that could be used to evaluate the importance of particle size reduction, contact time, and leaching fluid composition. Such an evaluation would consider the natural pH of the disposal environment in choosing a series of pH values at which leaching would be conducted. At least two liquid/solid ratios would be tested as well.

He noted that with a tiered approach, the user can better balance the costs against the type of data that is needed for decision-making, ultimately leading to better decisions, more appropriate use of limited landfill space, and an overall increase in environmental protection.

Dr. Kosson concluded his presentation by noting that the measurement of leaching parameters permits estimation of the constituents released in either default or site-specific scenarios and that the comparison of the default approach with site-specific conditions is an important aspect of leaching research. At the conclusion to his presentation, Dr. Kosson addressed questions and comments from the participants.

One participant reminded the group that changes to the leaching test procedure cannot ignore the fact that the RCRA statutes require that EPA provide a means to characterize wastes and identify those that pose a risk when mismanaged. Dr. Kosson replied that the mismanagement scenarios that he has studied and the allowance for different scenarios in the models are consistent with the RCRA statutes. Dr. Kosson noted that leaching tests are used for many other applications beyond RCRA characteristic testing and that if carefully designed, the uses of leaching tests for these different purposes need not exclude their use under RCRA David Friedman, of EPA, also responded, stating that while the RCRA statutes do require that the characteristics testing be based on a mismanagement scenario, the statutes do not specify *what* mismanagement scenario must be used.

Hans van der Sloot, of NERF, commented that one of the problems with metals such as arsenic is that they are greatly affected by the pH at which they are measured. He noted that in the range around pH=5, there is a steep slope in the arsenic solubility curve. Thus, without very careful control of pH, large differences in arsenic concentration can occur. Dr. Kosson replied that this was a good observation and noted that there are quality control procedures that can be used in modeling leaching behavior that allow the investigator to note the differences in the actual materials that were being leached and take actions to ensure accurate pH control. However, when the tests are applied in a regulatory sense, that ability to be flexible may not exist, leading to differences in the final results.

A participant commented that she felt that the testing procedure violated its inherent assumptions regarding issues such as compacted granular materials versus monolithic wastes. She asked if any validation studies had been conducted with real materials, such as cement block. Dr. Kosson

replied that there had been many comparative studies performed and that they have examined a wide range of crushed and compacted materials, etc. He offered to discuss the details of the validation efforts after the session.

Hans van der Sloot presented another comment, in partial response to the validation study question. He stated that stabilized wastes had been extensively tested and the results of the testing were used in a model that was designed to predict the changes that would occur over a 10-year period. The wastes were then placed in a landfill which was examined periodically over a 10-year period. He stated that after 10 years, the predicted leaching of some metals was within a factor of 2 of the observed results after 10 years, and that he considered this to be good agreement. He stated that other metals agreed within a factor 5, while a third group, including lead and zinc, only agreed within a factor of 10. He noted that the concentrations studied were low, on the order of milligrams per cubic meter in soil.

Bill Batchelor asked about the availability tests. Did a 1-point test mean that an extraction was only carried out at one pH, or that only one determinative analysis was conducted on the combined leachate from several pHs? Dr. Kosson replied that the details of the various alternative leaching approaches had resulted in an intense debate about this subject. He noted that workers in the Netherlands had conducted a round-robin validation study that looked at leaching wastes at pH=4 and pH=7, then combining the leachates for a single analysis. Another suggested approach was to use the asymptote of the pH-solubility curve and calculate the mass released at a known liquid/soil ratio. A third approach was for leaching at two pH values, with each leachate analyzed separately. Dr. Kosson indicated that while the issue was still being debated, he expected that the final approach would involve a compromise that allowed for a conservative implementation of an alternative leaching protocol, yet that would allow more rigorous approaches to be employed when needed.