Summary

This book is the third ASTM Special Technical Publication (STP), sponsored by ASTM Committee D-34 on Waste Disposal, on the subject of problem solving in waste disposal. The first volume[1] dealt primarily with laboratory waste analysis and land disposal considerations, such as siting and liners. The second volume[2] expanded on these themes and added sections on sampling and biological assessment. This third volume advances our knowledge of waste and disposal site analysis and the fate of wastes after disposal. Two new topics are introduced: waste management for resource recovery and international perspectives on waste management.

The papers included herein have undergone peer review and revision since their presentation. They provide state-of-the-art information on waste-related analysis and innovative options for waste management.

Analysis of Wastes and Waste Disposal Sites

In the last few years we have seen great activity in developing analytical methods to identify and quantify individual constituents in the unusual and complex waste matrix. Our confidence has grown to the point that we believe we can reasonably say what is in a waste. Although many refinements are still necessary, we can see a shift in effort toward understanding how the waste behaves in the disposal environment. Under the topic of waste and disposal site analysis only two papers deal with waste analysis. The remaining seven are directed toward understanding the effects of wastes on the environment.

Janisz and Butterfield examine correlations between waste site leachates and resident aquatic animals. Their experiences show that such studies are valuable when water contamination is well documented and the contaminants have high bioconcentration factors. The results of such studies are most effective when bioconcentration is shown or species diversity declines.

The study by *Young and Parker* on waste site odors offers a systematic analytical approach toward understanding this common problem. The key ele-

[1] *Hazardous Solid Waste Testing: First Conference, ASTM STP 760*, R. A. Conway and B. C. Malloy, Eds., American Society for Testing and Materials, Philadelphia, 1981.

[2] *Hazardous and Industrial Solid Waste Testing: Second Symposium, ASTM STP 805*, R. A. Conway and W. P. Gulledge, Eds., American Society for Testing and Materials, Philadelphia, 1981.

ments are acquiring representative, quantitive samples of the many diverse odorous chemicals. Three techniques are required for obtaining samples of the three types of odorous compounds. A larger number of techniques is required to identify and quantify the compounds of interest adequately. Finally, it appears that the age and decomposition rate of the waste are the most significant factors in odor generation.

The paper by *Belkin and Bishop* describes an approach for analysis of unlabeled containerized wastes found inside the waste generator property. The paper emphasizes the value of determining possible background information about the container. Once the background is established, general observations can lead directly to the most appropriate analyses.

Côté and Isabel analyzed simulated solidified wastes according to an established fixed repeating leachate generation schedule developed by the nuclear industry. The kinetics are appropriate for radioactive wastes but not for other solidified hazardous wastes. Typically, hazardous wastes have a wide variety of constituents, each of which leaches at a different rate. By using diffusion equations and variable leaching times to improve constituent detection, diffusion constants can be established. These derived constants can be used to predict how rapidly solidified wastes leach individual constituents.

Kilau and Shah researched the problem of acid leaching of chromium-bearing slags. They found that a slag calcium oxide/silicon dioxide concentration ratio of less than 2 minimizes leaching of chromium.

Cation mobility in soil has been studied by *Wong et al.* These authors percolated a complex cation mixture through a soil and measured the amount of each cation in the leachate. They developed a simple relationship using the linear distribution coefficient to predict relative migration rates and the distance of travel of each cation at any given time.

Oil contamination of soil is a common phenomenon that often requires environmental action. *Petros et al* evaluate five methods that could be used for on-site analysis of oil in soil. Useful methods should be reasonably accurate, simple enough for field work, and rapid enough to be used during the actual cleanup. Three methods, each useful for different situations, were found suitable for in-house studies.

Fly ash is generated in huge quantities in many nations. Each individual ash contains leachable metals in varying quantities. *H. W. Young et al* tested three chemical treatments to reduce fly ash leaching potential. Overall, portland cement treatment produced the best quality of leachate. Samples treated with lime and phosphoric acid showed mixed results. Ash from refuse-derived fuel had a more concentrated leachate. Leachates from wastes of different particle sizes showed surprisingly little variation in composition. This work provides a variety of ways to alter leachate quality and can be the basis for new studies.

Baker et al studied the relationship between cadmium loading in soil and passive plant uptake. These authors developed a logarithmic equation to relate leachable cadmium in soil to the cadmium content of plants. This work provides a basis for further study of metal uptake by plants, which should, in turn, provide the means to prevent overloading of agricultural soil with waste.

Amelioration of Wastes in the Disposal Environment

Wastes are often regarded as unmitigated evils, which, by definition, can do no good. The first paper in this section shows that a properly managed waste can become an asset. The next three papers show that well-considered codisposal can actually reduce the deleterious effects of either or both wastes. Finally, an improvement in the common formulation of liquid waste fixation can result in greatly reduced leaching potential.

Disposal of oily sludge on farmland is shown by *Mucsy et al* to be of actual benefit to sandy soil. The oil provides nutrients and improves water retention. If fertilizer is also applied, larger and healthier crops result. However, it is still prudent, on such soil, to raise crops not destined for direct human consumption.

Barber et al looked at disposal of oil emulsion waste with municipal waste. Their experiments show that the oil is retained by the waste but the water flows through. This work provides a set of conditions for environmentally sound codisposal.

Soda ash wastes can provide a suitable base for later disposal of steel manufacturing wastes. *Rinaldo-Lee et al* demonstrate that the characteristics of soda ash waste are well suited for treating and immobilizing leachable chromium from steel manufacturing waste.

Young, Baldwin, and Wilson present another example of one waste ameliorating the effects of another. Cations in industrial waste were attenuated by underlying municipal waste. Furthermore, fatty acid production and the concurrent pH drop in municipal waste was halted by the industrial waste.

Fixation of wastes with cement or fly ash is well known. *Falcone et al* studied sodium silicate addition to these formulations and found less matrix breakdown and less cation leaching.

Waste as Resource

This section naturally follows the first two, which discuss knowledge of waste and ways of putting some of the wastes characteristics to use. The five papers in this section illustrate how some wastes are really resources in disguise.

Food processing wastes characteristically have nutrient loadings so high that they can actually harm natural waterways. *M. H. Wong et al* used five such wastes as algae feed to produce food while reducing pollution.

Sanna and Camilli studied anaerobic digestion using seasonal agroindustrial wastes. They found that fixed-bed anaerobic digestion is more efficient than aerobic digestion, even in seasonal operations. However, methane production steadily increased during operation, indicating that optimization is slow.

Ferraiolo et al have developed optimization criteria for energy recovery from anaerobic digesters. Their equations use easily measured parameters to establish and monitor the process. Sewage is treated by activated sludge. Waste sludge is anaerobically digested, thus providing some energy and less waste for disposal.

Spent chromium plating solutions can become resources rather than wastes if processed using well-known ore processing methods. *Bolto et al* replaced sludge for ore in the process, used high-temperature oxidation and produced hexavalent chromium in useful concentrations.

National Perspectives in Waste Management

This section describes some waste management practices from around the world.

Rapid industrialization causes a wide variety of changes wherever it occurs. One of the changes often overlooked is the generation of many pollutants never seen before in the area. *Sundaresan et al* present in striking detail the magnitude of the problem in India. A similar, but more hopeful, theme is presented in the paper by *Hamza and Gallup* with examples from Alexandria, Egypt. Both papers amply illustrate the need to establish coordinated solid waste programs.

Schomaker describes the U.S. Environment Protection Agency (EPA) land disposal research program. This program requires development of reliable waste analyses, compatibility of the waste with the disposal method, and knowledge of the fate of the waste over time.

Gillen and Tusa examine one EPA approach for determining the fate of wastes over time. These authors categorized and prioritized cases of suspected environmental damage from land waste disposal or storage sites. Such information can be used to determine what wastes and what disposal methods are most dangerous.

Thailand's eastern seaboard has recently seen rapid industrial growth, and more is expected in the near future. *Ludwig et al* explain the Thai government's new role in systematic planning for present and anticipated pollution loads. The initial program calls for solids to be used for coastal land reclamation and liquids to be piped into the Gulf of Thailand. Monitoring of all disposal sites will determine when improved treatment is required.

El-Gohary and El-Khouly discuss waste management in the Egyptian iron and steel industry. Wastes are not merely washed away, as commonly practiced in many places. Solids are removed from waste streams, resulting in some solids and clarified water than can be reused. Wastes in Egypt are beginning to look like resources just as they are in Europe.

The European Economic Community (EEC) consists of ten member states which consider some national problems easier to solve with cooperative action. Pollution is one of the problems addressed by the EEC. As described in the paper by *Klein*, the EEC philosophy is to reduce waste volume and transform waste into a resource whenever possible while being cost-effective at the same time. As part of this approach, effort is made to discover processes and materials that produce less waste and consume fewer scarce resources.

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