nel and gate systems and in situ reactive zones. These systems are superior technically and cost effective. The technology is based on the creation of a subsurface zone where migrating contaminants are intercepted and permanently immobilized or degraded into harmless end products.

The authors cite an impressive list of contaminants susceptible to in situ treatment, among which are: chlorinated hydrocarbons, petroleum hydrocarbons, ethers, explosives, and dissolved metals.

Among the advantages or benefits of using this technology are: non-transfer of contaminants to other media; no ex situ waste generated; flexibility, etc. (14 separate benefits are noted in the text).

The second chapter deals with all aspects of Microbial Reactive Zones including enhanced reductive dechlorination, in situ precipitation of heavy metals (Ni, Cr, As, Cd), and in situ denitrification. Also discussed are the decontamination of sites containing perchlorates, dioxane, explosives, radionuclides and *N*-nitrosodimethylamine.

Chapter 3 is entitled "Chemical Reactive Zones". The authors note that "The popularity of chemical reactive zones for treatment of aquifer contamination increased dramatically in the mid-1990s. Although there is no central base of statistics on reactive zone applications, from publication of field applications in conference proceedings, it appears that oxidation has become the dominant chemical reactive zone strategy, with permanganate and Fenton's reagent methods leading the way. Of the chemical reducing zone strategies, zero-valent iron appears to be the most popular."

Chemical oxidation zones are discussed in the above chapter. The authors note, however, the cost of using this technology is often much higher than alternative solutions. Consequently, the decision to utilize this technique rather than a biological or natural attenuation system is most often driven by a requirement to achieve significant mass reduction in a short time interval. Remediation topics discussed in this chapter include, as noted, the use of Fenton's reagent, potassium permanganate, ozone and persulfate-based systems.

Chapters 4 and 5 deal with the implementation of the technologies discussed in the preceding paragraphs. Discussed (in Chapter 4) are site screening, site conceptual models, performance measures (process monitoring and groundwater sampling and analysis), system design, reagents, delivery system design and pilot testing.

In the final chapter, the authors discuss Building Reactive Zone Strategies:

"In this chapter, reactive zone structures are defined according to the physical, chemical, and biological processes that occur within, and downgradient from, the locations at which the managed reactions occur. Each of the identified zones – injection, reaction, desorption, and recovery – is a working component of an IRZ strategy. Reactive zones are deployed in several possible patterns including source zone, barrier, and whole-plume treatments, according to the project scope and timing objectives.

The chapter concludes with discussions of limitations on reactive zone effectiveness in contaminated aquifers. The fundamental problems of reactive zone design and operation include the challenge of achieving contact between reagents and target compounds, the variable distribution of reagent concentrations, and the associated impacts of reaction kinetics and by-product formation. Contaminant distribution factors such as the presence of nonaqueous-phase liquids DNAPLs and large-scale sorbed mass add further to the difficulty of reactive zone design and operation."

Through my association with US-EPA Hazardous Substance Research Centers, I have been exposed to many of the topics discussed in this book. Indeed, some cited references have been to these research center projects. To the extent that I have acquired knowledge of remediation problems and solutions, I can state that book is well written, well researched and well worth acquiring.

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Roger D. Spence, Caijun Shi (Eds.), Stabilization and Solidification of Hazardous, Radioactive, and Mixed Wastes, CRC Press, Boca Raton, FL, 2004, ISBN 1-56670-444-8, p. 390 (USD 189.95).

Stabilization, the authors note "...refers to techniques that chemically reduce the hazard potential of a waste by converting the contamination into less soluble, mobile, or toxic forms." They then define solidification as "...techniques that encapsulate the waste, forming a solid material, and does not necessarily involve a chemical interaction between the contaminants and the solidifying additives."

In their introduction, Spence and Shi state:

"Stabilization/solidification is typically a process that involves the mixing of a waste with a binder to reduce the contaminant leachability by both physical and chemical means and to convert the hazardous waste into an environmentally acceptable form for land disposal or construction use." Wastes treated by this process include low-level radioactive wastes, hazardous and mixed wastes. This process has numerous advantages (19 specific advantages are cited by the

authors) among which are: relatively low cost, good long-term stability, good impact and compressive strength, and high resistance to biodegradation.

The editors describe their book and its contents as follows:

"This book is intended to provide the regulatory and scientific basis for the use of S/S processes, a description of different S/S systems, a description of the testing and evaluation of the materials before and after treatment, and finally a summary of some previous field applications of S/S. Chapter 2 discusses the general guidelines for developing a waste form for a given application, giving two decision flow path schematics. Chapter 3 discusses characterization and classification of waste, an important preliminary step in treating waste or remediation sites. Binders are discussed in Chapters 4 (cement), 5 (polymers), and 6 (phosphate, sulfur polymer cement, gypsum, and hydroceramic). A variety of additives or sorbents are available to minimize interference with the hydration of cement or to enhance the immobilization of contaminants. Common additives or sorbents include activated carbon, zeolites, clays, carbonate, oxidizing agent, reducing agent, sulfides, organoclays, iron, and aluminum compounds. Chapter 7 discusses interactions between contaminants and binders, and Chapter 8 discusses some of the additives used to enhance binder properties or contaminant stabilization. Chapter 9 discusses the microstructure of S/S waste forms. Chapter 10 discusses the leachability from S/S waste forms. Chapter 11 discusses the evaluation of waste forms, their durability, and the test methods used. Chapter 12 discusses QA/QC for S/S. Chapter 13 presents four applications of S/S to real-world problems, one going back three decades that is still relevant today, one a more recent hazardous site, and two at USDOE sites."

The above brief recitation by the editors of the book's contents well-describes its coverage that ranges from the theoretical to the practical. The latter (practical) is the topic of the final chapter which is entitled "Case Studies: Full-Scale Operations and Delivery Systems." It was written by Jesse Conner and two colleagues (Conner is a long-time practitioner of stabilization/solidification); his book published in 1990, *Chemical Fixation and Stabilization of Hazardous Wastes*, is a classic reference in the field.

In the above noted chapter, four case studies are presented to give a fairly broad view of full-scale operations employing cement-based systems. These case studies are entitled:

1. Lead-contaminated soil at a former battery processing site;
2. In situ stabilization of mixed waste contaminated soil;
3. Solidification of liquid waste contaminated with antimony;
4. Radioactive waste stabilization at the US Department of Energy Savannah River Site.

Solidification/stabilization of wastes has been a topic discussed in many papers in the Journal of Hazardous Materials, including several papers written by contributors to this book. Spence and Shi have utilized a significant number of well-recognized researchers in the field to produce this very useful and authoritative volume to review and highlight these very useful remediation techniques.

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Louis Theodore, Robert G. Kunz, Nanotechnology: Environmental Implications and Solutions, John Wiley & Sons Inc., Hoboken, NJ, 2005, 396 pp., US$ 99.95, ISBN 0-471-69976-4.

At the same time as Wiley sent me this book, I received a University of Michigan Alumni Magazine whose title article was "Nanotechnology – going small has a big future." One of the columns in this article described research on the use of nanoscale systems for the removal of heavy metals from groundwater. There were other potential applications discussed in this article in health (quantum dots for medical imaging), energy (layer-by-layer assembly for solar cells and fuel cells) and even homeland security (nanocomposites to combat chemical and biological terrorism). Numerous other potential applications of nanotechnology are cited by the authors of this book in their first chapter. Clearly, this is an exciting new area of technology with many potential applications.

However, in addressing the title, the book's content is woefully weak. Indeed, the authors state "To the authors' knowledge there are no documented nano-human hazards. Statements in the literature refer to potential health problems." Theodore and Kunz then go on to describe a recent study that showed inhaled nanosized particles accumulate in the nasal cavities, lungs, and brains of rats.

Clearly, a research note such as described in the previous paragraph is important and should be carefully considered. To this end, the authors note "...that nano-environmental concerns are starting to be taken seriously around the globe." In this context, the book is forward-looking with a view to preventing problems from being caused by a new technology.

Given there are no real technology-based nanoscale-caused environmental problems, there is little directly for the authors to address vis-a-vis environmental problems resulting from nanoscale production and/or use. What the writers do in the greater part of the text is to rehash conventional environmental technology concerns. They do this