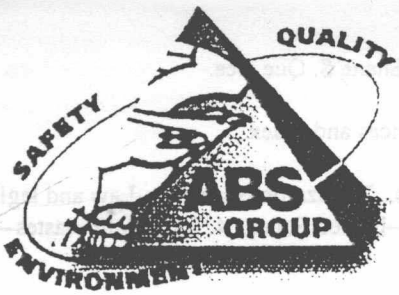
Hazardous Waste Analysis

HAZARDOUS WASTE ANALYSIS

SHANE S. QUE HEE



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DEDICATION

To my advisees for many years of love of science, sweat, tears

Preface

Who Is This Book For?

This book is a unique introduction to the identification and analysis of hazardous waste from cradle to grave. The book has been written for public health, environmental health, environmental chemistry, and environmental engineering professionals, as well as for lawyers, employers who are generators of hazardous waste, and the science-literate public. It is suitable for a graduate or an undergraduate senior-year course in hazardous waste management or hazardous waste analytical chemistry and presumes a first-year university knowledge of chemistry, calculus, biology, and physics. It grew out of courses I have taught at the University of Cincinnati and at UCLA.

Section Flow

Section I integrates hygiene, safety, basic science, and engineering aspects with the regulatory requirements. Section II deals with the legal requirements to identify a solid waste as hazardous, along with the complementary science. Section III considers the field sampling and field analysis aspects, together with the accompanying science. And, Section IV discusses the laboratory analysis of hazardous waste and polluted media, also in context with basic science.

In real life, each of these activities is usually compartmentalized, but "times are a-changing":

- The hazardous waste industry requires a "cradle-to-grave" chemical perspective for its participants;
- University educational programs are also becoming increasingly inter- and multi- disciplinary.

Traditionally, engineers have occupied major positions in hazardous waste areas, and this situation will not change for treatment, storage, or disposal (TSD) facilities. There is a need for professionals based in chemistry, biology, statistics, and risk assessment also, but especially for interim TSD facilities, including the vast number of hazardous waste generators. The reluctance of industrial and environmental hygienists and their training programs to come into close quarters with the analytical chemistry of hazardous wastes needs to be rectified, another reason for the publication of this book.

The juxtaposition of all these elements makes this book not only a practical introduction to the regulatory industrial hygiene, safety, and engineering aspects of hazardous wastes, but also a companion introduction to SW846, *Test Methods for Evaluating Solid Waste*.

What to Include?

Some hard decisions had to be made about to what to include in this book. The following are some elements that went into those decisions:

- All the CFR and *Federal Register* notices on hazardous waste alone would create a 100-volume series. Therefore, I had to make judicious selections of material
- Unless illustrations were crucial, and not readily available in other sources, I kept these to a minimum.
- Due to space constraints, not all of the Department of Transportation (DOT) hazardous material tables could be published. Therefore I included one section of NAERG96 instead.
- Another problem involved just how specific I should be on SW846 Method materials. I opted for basic science concepts rather than specific directions such as the following: "take up 1 ml by depressing the plunger to the first resistance while the tightened pipet tip is immersed in the sample solution; wipe the

pipet tip with a Kimwipe." The guidelines here cannot replace updated specific SW846 Method material, since these continually change. However, the basic principles of each method do not vary that much, and new Methods involve new principles at any rate.

I deemed the principles to be of more importance than a "how-to" manual, because scientific principles are also the keys to understanding future developments.

Section I illustrates the approach in microcosm. Although legal definitions are provided in the Glossary of Legal Terms, the scientific definitions can differ. Section I provides not only training requirements, but also the specifics of what a worker is trained to do, and enough science to appreciate when regulations may not work.

Section II assesses the toxicity characteristic leaching procedure as a test of the availability and bioavailability of toxicants, how U.S. EPA corrosivity and U.S. DOT/UN corrosiveness are interrelated, and how ignitability, reactivity, and waste incinerability are interpreted through thermodynamics and kinetics.

Section III, I opted for the more practical aspects of field sampling and direct-reading methods, rather than focusing on procedures that involve skilled professionals who already know their jobs. However to implement these methods, the basics of adsorption, kinetics, and partitioning are essential.

Section IV discusses the aspects of laboratory analysis. The chemical analyst must understand the use of the Snyder *P'* parameter to predict solvent compositions for liquid chromatography (LC) separations should SW846 standard method prescriptions for partition LC fail, as they will for many matrices. The application of modified van Deemter theory to chromatographic separations is also necessary, given that for a new matrix, a standard method must generally be modified to work for the new chemical matrix.

I Don't Care How You Do It: I Want Answers!

It is a common belief, often held by administrators who want instant answers, that all standard methods do not involve research, and that the technician or analyst is a robot who follows a recipe and shoots the material into the instrument and thus scores the answer without mental effort. This is erroneous. But, this view tends to be persistent because, to a harried administrator, the answers may be more important than how they were obtained, a scenario familiar to everyone. Every chemist knows, however, that how answers were obtained determines data quality. Quality assurance and quality control cannot be ignored, even if it is expensive and apparently unrelated to the sample analysis itself, a source of continuing frustration for nonchemists. Thus, this volume, it is hoped, will also help educate the management, business, and economic end of the hazardous waste management spectrum.

International Issues

Finally, the place of the regulated U.S. community in the world community has steadily become more isolationist in recent years in the face of the International Organization for Standardization (ISO) and its voluntary standards, ISO 9000 of 1987, and ISO 14000 of 1996, which are discussed in Chapter 1. The United States is an ISO member through the American National Standards Institute. More than 111 countries are parties, and by the end of 1996 more than 120,000 international corporations had been ISO certified, including more than 2,500 in the United States. All U.S. corporations wanting to do business with European Common Market countries must now be ISO certified. Maximization of profit must include consideration of factors related to international business.

Although the UN numbering system for wastes is now used throughout the United States, the international political aspects of hazardous waste and the litigiousness of waste management regulation in the United States have rarely been discussed in a scientific context. This book changes that approach.

The hazardous waste industry now is international and not just confined to the developed countries. In the 1980s, the wholesale dumping of hazardous wastes in developing nations became of concern and led to the

drafting of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal. As of 1998, the Convention had been ratified by 118 countries. The United States is the only developed country that has not ratified it. The convention seeks to meet the following goals:

- Reduce the generation of hazardous wastes
- Ensure environmentally sound waste-disposal facilities
- Minimize transboundary movement of hazardous wastes
- Prohibit shipments of hazardous wastes from a country that is party to the convention to one that is not.

The 1998 meeting of signatories endorsed specific lists of hazardous wastes (List A) and nonhazardous wastes (List B). Included among the latter were many recycled wastes, the bone of contention at previous meetings. There is also a List C of unassigned wastes. To be implemented in the United States, amendment of the Resource Conservation and Recovery Act, the legislation that governs generation, storage, treatment, and disposal of actively generated hazardous wastes in the United States, is needed to prohibit Basel-listed waste exports that are not to be handled in an environmentally sound manner abroad, and to repatriate wastes shipped illegally. This will take time.

These instances show that the United States must also be a member of an international community, as well as keep its own house in order. This book is primarily about the latter aspect. Although regulation is necessary and can be effective through "trickle-down" processes at the administrative levels, the regulatory "grass roots" are the professionals in public health, environmental health, occupational health, chemistry, engineering, biology, mathematics, physics, economics, management, law, and environmental policy, in addition to the generators themselves. These individuals must know not only the letter of the law but also its spirit. They must also know how scientific expertise needs to be wedded to the letter of the law and be the leaders of tomorrow in their fields, all without committing professional suicide. This book attempts to syncretize that spirit and that letter.

About the Author

Shane S. Que Hee was born in Sydney, Australia in 1946. He obtained a Bachelor of Science with honors in chemistry and biochemistry in 1968, and a Master of Science degree in physical chemistry in 1971 from the University of Queensland. For the latter, he did research on detecting weak light emission from living cells under the supervision of Professor Terry Quickenden. During his doctoral work in the Department of Chemistry and Chemical Engineering at the University of Saskatchewan in Canada from 1971 to 1976, under Professor Ronald Sutherland, he researched the environmental analytical chemistry and environmental fate/transport of chlorinated organochlorine pesticides, focusing on the chlorinated phenoxy herbicides. His postdoctoral work in the Department of Chemistry at McMaster University of Ontario, Canada, under Professor Edward Hileman, Jr., from 1976 to 1978, was on the biophysics of liquid-crystalline organic vesicles.

Dr. Que Hee was appointed Assistant Professor in Environmental Health at the University of Cincinnati in 1978 and obtained tenure there in 1984 as Associate Professor. He transferred as Associate Professor into the Department of Environmental Health Sciences in the UCLA School of Public Health in 1989 as a faculty member of the UCLA Center for Occupational and Environmental Health. He was Department Vice-Chair from 1991 to 1994 and became Full Professor in 1994.

The author is a Fellow of the American Institute of Chemists and of the American Industrial Hygiene Association, and a Registered Professional Industrial Hygienist. He was a member of the National Library of Medicine's peer review committee for the Hazardous Substances Data Bank (HSDB) from 1985 to 1989. Other technical national organization committee memberships include the Biological Monitoring Committee of the American Industrial Hygiene Association since 1993, and the Joint Editorial Board of *Standard Methods for the Examination of Water and Wastewater* since 1993. He received a Certificate of Award in Recognition of Noteworthy Contribution and Special Achievement for the U.S. EPA in 1981.

Dr. Que Hee has organized four symposia for the American Chemical Society and two for the American Industrial Hygiene Conference and Exposition. He has 115 peer-reviewed publications: 88 in scholarly journals, 18 book chapters, and 3 books, and he is chapter author in 6 U.S. EPA Criteria Documents. *The Phenoxyalkanoic Herbicides: Chemistry, Analysis, and Environmental Pollution*, with Professor Sutherland in 1981, was the first book on chlorinated phenoxy herbicides. *Biological Monitoring: An Introduction* with Professor Que Hee as contributing editor, was the first graduate textbook on human biological monitoring in the area of industrial and environmental hygiene. Dr. Que Hee has pioneered the teaching of biological monitoring and hazardous wastes analysis in the United States. He has also pioneered research into inductively coupled plasma–atomic emission spectroscopy, direct-reading instruments, integrated methods of air sampling in industrial and environmental hygiene, workplace protection factors of particulates and vapors, pesticide formulation permeation through gloves, availability/bioavailability of xenobiotics, bioassays as genotoxicity screening tools, and biological monitoring.

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Section I

General Legal and Health Requirements

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Section I