

hydrozirconation¹¹–transmetalation,⁶ as we suggested recently, this side reaction should be prevented by choosing an Al–Zr reagent system which does not readily undergo transmetalation to form an *n*-Pr–Zr species. Examination of a 1:1 mixture of *n*-Pr₃Al and Cl₂ZrCp₂ in 1,2-dichloroethane by ¹H NMR spectroscopy at ambient temperature reveals, as expected, the formation of *n*-Pr(Cl)ZrCp₂¹² (≤60%) along with Cl₂ZrCp₂ (40–45%). On the other hand, a 1:1 mixture of *n*-Pr₂AlCl and Cl₂ZrCp₂ does not show any sign of *n*-Pr–Cl exchange, as judged by ¹H NMR spectroscopy. We have therefore treated 1-heptyne with *n*-Pr₂AlCl and Cl₂ZrCp₂ in a 1:1:1 ratio and have indeed obtained, after protonolysis, 2-*n*-propyl-1-heptene and (*E*)-4-decene in 76 and 21% yield, respectively, with no more than a trace of 1-heptene. Although the generality of this modified procedure

is yet to be explored, we may now have at hand a means of circumventing the undesirable hydrometalation. This and other aspects of the Zr-catalyzed carboalumination are under active investigation.

Acknowledgment is made to the National Science Foundation and the donors of the Petroleum Research Fund, administered by the American Chemical Society, for support of this research.

(11) For a review, see: Schwartz, J. *J. Organomet. Chem. Libr.* **1976**, *1*, 461–488.

(12) The reaction of (Cp₂ZrCl)₂O with 2 equiv of *n*-Pr₃Al in CH₂Cl₂ in a manner reported for the preparation of Me(Cl)ZrCp₂⁴ gives *n*-Pr(Cl)ZrCp₂ in ~40% yield: ¹H NMR (ClCH₂CH₂Cl, Me₄Si) δ 0.7–1.1 (m with a triplet at 0.82 ppm, *J* = 7 Hz, 5 H), 1.2–1.8 (m, 2 H), and 6.16 (s, 10 H).

Book Reviews*

Infrared Characteristic Group Frequencies. By G. Socrates (Brunel University). John Wiley & Sons, New York, 1980. xi + 153 pp. \$72.00.

When using infrared as an analytical tool to solve chemical problems, it is important to have a number of references available that correlate absorption regions with structural units. This book is clearly intended for that purpose. It contains only charts and tables listing regions where large numbers of organic and inorganic compounds absorb, accompanied by a textual discussion of these patterns of absorption organized largely by types of bonds, functional groups, and/or compound class. There is also a brief chapter on the near infrared. About two-thirds of the book is devoted to a chapter-by-chapter rendition of compounds traditionally associated with organic chemistry and the remainder is devoted to inorganic compounds, organometallic compounds, etc. The book has an unusual page size (they are much wider than they are tall), very probably in an effort to accommodate the charts. One of the charts (Chart 1) has a novel approach: it is a “negative” correlation chart, that is the absence of a band in the so-noted region implies the absence of the functional group or chemical class listed. Charts 2 and 3 are more like the usual correlation charts: Chart 2 (seven pages) lists absorption regions (from high to low wavenumber) and the functional groups likely to cause absorption in that region. Chart 3 (thirteen pages) is, on the contrary, listed in order of functional groups and *all* regions in which that particular functional group might absorb are listed, as well as the vibration that causes each absorption.

The strengths of this book are the charts as well as the extensive tables that are spread throughout the chapters. A spot check indicates that the references listed that support the tables frequently supplement (rather than reproduce) the references listed for the same functional groups listed by Bellamy and by Colthup et al. A scan of the references listed at the end of each chapter does raise an eyebrow; these references are rarely recent (very few are publications that have appeared since 1974). A similar scan of the two books listed above does, however, yield essentially the same result.

In summary, it does appear that this book represents a worthwhile addition to an institutional library (although, at \$0.50 per page it is unlikely to be added to many personal libraries). Finally, there is a section added in appendix form titled Further Reading. This seems to be a collection, in no particular order, of general reading that could serve to supplement the text. My concern about up-to-date references again surfaces. Due to this concern and due to the fact that above I have mentioned some of these books, I will list below some books that certainly should be considered as supplements or alternates to this text. I also note that none of these were cited in the text by Socrates (although earlier editions of some were cited).

L. J. Bellamy, “The Infrared Spectra of Complex Molecules”, Vol. 1, 3rd ed., Halsted Press (Wiley), New York, 1975.

N. B. Colthup, L. H. Daly, and S. E. Wiberly, “Introduction to Infrared and Raman Spectroscopy”, 2nd ed., Academic Press (Harcourt, Brace Jovanovich Publishers), New York, 1975.

K. Nakamoto, “Infrared and Raman Spectra of Inorganic and Co-

ordination Compounds”, 3rd ed., Wiley-Interscience, New York, 1978.

E. Maslowsky, Jr., “Vibrational Spectra of Organometallic Compounds”, Wiley-Interscience, New York, 1977.

D. Dolphin and A. Wick, “Tabulation of Infrared Spectral Data”, Wiley-Interscience, New York, 1977.

Terence C. Morrill, *Rochester Institute of Technology*

Manual of Economic Analysis of Chemical Processes. By A. Chauvel, P. Leprince, Y. Barthel, C. Raimbault, and J.-P. Arlie (Institut Francais du Petrole). Translated by R. Miller and E. B. Miller. McGraw-Hill Book Company, New York, 1981. xiv + 462 pp. \$37.95.

This excellent translation of the 1976 French original is a valuable handbook of cost estimation methods widely used in the petroleum and petrochemical industry. More than a mere compendium of equations, it is a readable step-by-step description of the techniques of economic analysis. These techniques, gathered, developed, and refined over the years by the staff at IFP, will be very useful for cost estimators, market researchers, process development engineers, and consultants. Cost estimation methods developed by operating companies, consultants, and contractors are usually jealously guarded, and IFP is one of the few leading research organizations that would consider publishing the results of many years work in this way. Founded 35 years ago and funded by a portion of the French gasoline tax, IFP is also obliged to promote the dissemination of knowledge and know-how through publication.

The 228-page text is divided into five chapters: (1) Market Research, (2) Elements of Economic Calculation, (3) Investment Costs, (4) Cost Estimating for Industrial Projects, and (5) Evaluating Research Projects. Each chapter is followed by one or two detailed examples, illustrating the book's subtitle, “Feasibility Studies in Refinery and Petrochemical Processes”.

The first chapter on Market Research serves as a reminder that the availability and price of raw materials and products must be ascertained before a detailed design project can be undertaken, and changes in any of these factors must be constantly monitored during the project.

Chapter 2 gives methods for calculating investments and operating costs (fixed costs and variable costs) and details of all the most widely used techniques for calculating profitability of a project (payout time, discounted cash flow, return on investment, etc.). Chapter 3 gives additional details on investment costs, including estimates of accuracy, effects of location, and how to adjust for inflation.

Chapters 4 and 5 show how to apply these principles to industrial projects and research projects, respectively.

Thirteen appendixes occupy 211 pages. Eleven of the appendixes deal with sizing and cost estimation of major types of processing equipment. Pricing data and pricing methods (useful for scale-up) are presented in detail. The prices are given in dollars, as of 1975, for a U.S. location. Incidentally, all of the methods given in the text apply primarily to plants in the United States. Short-cut design methods for sizing process equipment have been compiled from standard sources and presented in a convenient way. Reflecting European practice, metric units are used in most cases, and this provides a good source of methods for the engineer trained in their use, or for anyone who would like to become accustomed to designing in metric units.

A bibliography gives the sources of the sizing and cost estimation data and methods. It is selective, but gives all the most important references up to 1976.

* Unsigned book reviews are by the Book Review Editor.

IFP's book is a valuable addition to the economic analysis bookshelf. Other books in the field include those by Peters and Timmerhaus, which contain more background on design methods; Happel, which is not so comprehensive; and Resnick, which emphasizes analysis of the design more than analysis of the economics.

Robert H. Schwaar, *SRI International*

Pulp and Paper: Chemistry and Chemical Technology. 3rd Edition. Volume 1. Edited by James P. Casey. John Wiley and Sons, New York. 1980. xxvi + 820 pp. \$55.00.

This third edition differs from the first two in that James P. Casey is editor rather than author. The loss in continuity as the result of having multiple contributors has been minimized; they have undoubtedly made for a more up-to-date and complete text than could be possible with a single author. This four volume series is organized generally along the steps in the papermaking process. Volume 1 is concerned with pulp preparation.

The opening chapter on cellulose and hemicellulose is well-written, but terse. Statements such as, "more detailed discussions of... can be found in reviews by...", occur frequently in this and other chapters. Most chapters are well-referenced; chapter two on lignin, in addition to an authoritative verbal and well-illustrated presentation, has nearly 400 references. As an example of this edition's inclusion of modern concerns, such as wiser utilization of natural resources, the pulpwood chapter also includes less traditional fiber sources. Chapter four on pulping, which makes up one-half of this volume, does a good job of relating resultant paper properties to both fiber source and process. This chapter with its more than 1100 references discusses with clarity the major processes as well as progress and trends in pulping, and still has space to include non-wood fibers, paper recycling, and silvichemicals. The last chapter, bleaching, is particularly strong in its chemical aspects, and as in other sections of the book includes information on environmental problems, controls, and related costs.

The authors appear to be well-informed in their respective subject areas. A glossary would have been helpful as there is some lack of uniformity in terms among the 13 authors of this volume. Credit is given for the cross-referencing of related topics between chapters.

I feel Volume 1 is a good sourcebook for students as well as practitioners of the science and business of pulping.

C. Eugene Cain, *Millsaps College, Winterthur Museum*

The Poisoning of Michigan. By Joyce Egginton (The Observer, London). W. E. Norton & Co., New York. 1980. 351 pp. \$13.95.

This book provides yet another well-written, reasonably detailed, and tragic case history for use by those of us who teach courses in environmental chemistry, environmental science, and the like. The contamination of the state of Michigan with polybrominated biphenyls mistakenly delivered to a feed manufacturer in lieu of a magnesium oxide feed supplement in 1973 resulted in a chemical disaster comparable to the contamination of Seveso, Italy, with dioxin, our Love Canal, the mercury and PCB poisonings of the people of Japan, and the mercury and hexachlorobenzene poisoning episodes which have occurred in Iraq and Turkey. Mrs. Egginton has written a layman's history of this episode, focusing on the human, political, scientific, and medical aspects, and slanting it toward a general audience.

The book is organized chronologically, with the first section concerned with the efforts of Rick Halbert, a dairy farmer, and Ted Jackson, a veterinarian, to find out what was causing Halbert's cattle to sicken and die. Their intelligence and tenacity in the face of industrial stonewalling and the indifference of the various government bureaucracies would eventually prevail, but it was a slow business. Key information obtained by Allen Piers and Allan Furr at the National Animal Diseases Lab at Ames nearly cracked the problem of the identification of the toxic contaminant; Furr obtained GLC traces of what subsequently turned out to be PBB's, but was taken off the project by his USDA superiors before the compounds could be positively identified. Had the problem at this time been referred to the USDA research station at Beltsville, which had a mass spectrometer, the problem would surely have been solved in short order. This was not done. Two months were to pass before positive identification was made by George Fries at Beltsville.

The book then discusses the efforts to determine how events at Michigan Chemical and Farm Bureau Services had led to the presence of massive quantities of PBB's in cattlefeed. It describes the quarantining of farms, the wholesale destruction of livestock and poultry, and the slow and grudging restitution made to some (by no means all) of the farmers who had been ruined. It also describes the gradual realization that the slowness of the action taken by the government agencies involved had resulted in the contamination of most of the people of Michigan with PBB. Farmers began to realize that low-level PBB contamination of their herds destroyed them nearly as surely, although more slowly, as did

high-level contamination. One chapter is devoted to the impact of high levels of PBB contamination on the health of the farm families who were exposed—it does not make pleasant reading.

The last section of the book deals with some political aspects of the problem and with a lengthy legal case involving low-level contamination in which apparently justice did not prevail. Some of the farmers whose cattle were obviously sick but did not exhibit the extremely high levels of PBB necessary for quarantine, destruction of the animals, and reimbursement for their value destroyed and buried them to keep them off the market, thereby reducing the extent of human contamination. In making these massive and voluntary sacrifices they showed a level of public morality in marked contrast to that exhibited by most of the politicians, state and federal bureaucrats, and involved industrial people. This section also describes the efforts of the farmers toward grass-roots community organization to deal with the numerous facets of the problem. One chapter is devoted to Irving Selikoff's study in mapping out the extent of the human contamination problem, and the efforts made to smear this work by members of Michigan's agricultural establishment and its legislature.

One of the more interesting aspects of the entire PBB problem is certainly the nearly complete inability of the various government bureaucracies to initiate prompt and effective action to investigate and deal with the problem. Buck-passing, intergroup jealousies, poor communications, totally inadequate budgets for dealing with anything of this sort, and overly friendly relationships with the industries they were allegedly regulating apparently made it impossible for them to do the job the public counts on them to do. One of the more disturbing things about this book is that it gives one no cause to believe that this sort of thing could not happen again. One hopes that Mrs. Egginton's excellent book will help us to see our way clear to changes in law and in attitude that will prevent or at least promptly defuse such disasters in the future.

David J. Wilson, *Vanderbilt University*

Colour and Constitution of Organic Molecules. By John Griffiths (University of Leeds). Academic Press, New York. 1976. xi + 281 pp. \$20.75.

When students are first introduced to organic chemistry, especially in the laboratory, their interest is often caught by the manifestation of color, and the better students are not well-satisfied by the sparse treatment given to the subjects of dyes and color in modern textbooks. This book, which is reviewed much later than it should have been, is designed to provide an introduction to the theory of color in organic molecules in modern terms, and to illustrate the concepts with representative types of chromogens. The examples include not only synthetic dyes and pigments, but the biologically important natural pigments, such as those involved in vision, and, for analytical chemists, indicator substances. The author shows how color and absorption in the visible spectrum is, in important details, different from ultraviolet absorption, and that the common introductory approach of presenting UV-vis spectra as an undifferentiated subject is a considerable oversimplification. There are enough tables and literature citations to give this book reference value, and it has a good subject index.

Speaking of Science. Volume 51. Proceedings of the Royal Institution of Great Britain. Taylor and Francis Ltd., London. 1979. vii + 163 pp. \$8.00, softcover.

This publication consists of evening lectures given to the Royal Institution during the 1977-1978 session. Of particular chemical interest are the contributions of A. D. Bangham, Model Membranes from Membrane Molecules, and L. Salem, A Faithful Couple: The Electron Pair.

Lecture Notes in Chemistry. Volume 8. Theory of Chemical Elementary Processes. By E. E. Nikitin and L. Zülicke (USSR Academy of Sciences). Springer-Verlag, New York. 1978. ix + 175 pp. \$8.90, softcover.

This publication is a review of molecular collision theory including classical, semiclassical, and quantum-mechanical formulations.

Lecture Notes in Chemistry. Volume 18. Collision Theory and Statistical Theory of Chemical Reactions. By S. G. Christov (Bulgarian Academy of Sciences). Springer-Verlag, New York. 1980. xii + 322 pp. \$27.70, softcover.

This publication contains a general survey of current theoretical approaches to chemical reaction dynamics. The author outlines the three main aspects of the problem: (1) the potential energy surface, (2) classical, semiclassical or quantum-mechanical trajectories, and (3) statistical computation of rate constants.