Isotopes in Chemistry

Isotopic Studies of Heterogeneous Catalysis. ATSUMU OZAKI. Kodansha, Tokyo, and Academic Press, New York, 1977. viii, 240 pp., illus. $25.

Isotopic tracers provide the most powerful tools for investigating the mechanisms of chemical reactions. This book by Ozaki is the most comprehensive, well-written, and useful treatise that has been published on the application of these techniques to heterogeneous catalysis. It should be a prime resource to all serious researchers who are studying the fundamentals of catalysis.

Beginning with a rather abbreviated discussion of analytical methods and a beautiful section on the mathematical formulation of rate equations for isotopic exchange, the book deals primarily with specific examples in which isotopic tracers have been used to shed light on the activity of catalytic surfaces, the nature of adsorbed species, reaction pathways, and rate-limiting steps in catalytic reactions. Over 700 references introduce the reader to a wealth of detailed information from all over the world, which is accurately and succinctly summarized in the book. Occasional footnotes referring to papers that were published while the book was being printed assure that the material is current. In addition to the usual author and subject indexes, there is a catalyst index that greatly enhances the utility of the book.

Essentially all known types of catalytic reactions have been investigated with the use of isotopic tracers; most of these are mentioned somewhere in the book. Ozaki has done extensive isotopic tracer studies of ammonia synthesis catalysts, and he covers this topic most thoroughly. In addition, there is excellent coverage of oxidation and ammoxidation (evidence for allylic-type intermediates), catalytic cracking (carbonium ion surface species), hydrogenation (singly and multiply bonded complexes), and dehydrocyclization (dual functional sites). Both stable (deuterium and ^{13}C) and radioactive (^{14}C) tracers have shed light on the bond rearrangements that occur during the intriguing disproportionation (metathesis) reaction of propylene into 2-butene and ethylene. That skeletal isomerization of hydrocarbons proceeds through cyclic intermediates has been clearly demonstrated by use of ^{13}C tracers. Reactions involving CO and H_2 to produce synthetic fuels and chemicals (for example, Fischer-Tropsch and methanol synthesis) are also covered.

Most types of commercial and experimental catalysts are dealt with. These include all electrical types from insulators to semiconductors to conductors; in composition they encompass electron donors and acceptors, oxides, and metals.

The last chapter, on isotope effects, is particularly useful, for it beautifully ties together a vast range of rather fragmentary information. Tables comparing results from various laboratories allow one to see at a glance areas where there is agreement—and sometimes disagreement. In several places where there is apparent conflict, Ozaki has offered reasonable explanations for the discrepancies. Throughout the book, brief summarizing statements listing the major conclusions follow the presentation of results.

Several important review articles are cited in the book. The only omission I noticed was of the published proceedings of a symposium organized by Happel and Hnatow, "The Use of Tracers to Study Catalytic Reactions" (*Ann. N.Y. Acad. Sci.* **213** [1973]). Ozaki's book is an extremely important one in catalysis, and I heartily recommend it.

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Atomic Scattering

Potential Scattering in Atomic Physics. P. G. BURKE. Plenum, New York, 1977. viii, 138 pp. $22.50.

There exist several books on the subject of potential scattering in atomic physics that are more comprehensive than the present one. What Burke has attempted to give here is a distillation of some of the modern developments of the theory of electron scattering from atomic systems (including atoms and ions but not molecular targets). In a sense the title of the book is too narrow—the theory encompasses effects in elastic scattering coming from many electron targets, notably exchange. What are not included are the many-channel effects associated with excitation and ionization.

The first chapter is really a preface. The next two chapters cover essential background material: the partial wave expansion for potential scattering as well as scattering from a Coulomb potential. Because the treatment is brief, no discussion of peripheral yet important points is given. For example, there is no mention of the interesting paradoxes, so well discussed in Schiff's *Quantum Mechanics*, implicit in the idealization of an infinitely wide incident beam in the time-independent treatment of scattering.

The fourth and fifth chapters deal with the exchange approximation in electron-hydrogen scattering. Their main concern is how the identity of incident and orbital electrons yields amplitudes leading to spin polarization effects both with and without the inclusion of spin-orbit forces. I found the chapters worthwhile; the reader who is interested in the theoretical essence of the subject may very well find Burke's book more helpful than Kessler's recent monograph, *Polarized Electrons* (but it will not replace Kessler's book over the whole range of the subject).

Chapter 6 is devoted to effective-range expansions, including modifications induced by the long-range polarization potential, and to quantum defect theory. The chapter also includes a brief discussion of repulsive potentials, but no reference is made to the masterly review by Frank, Land, and Spektor (*Rev. Mod. Phys.* **43**, 36 [1971]), which would have been an invaluable source for the interested reader.

The seventh chapter, on bound states and resonances, is the heart of the book. It covers four topics: the decomposition and analytic structure of the S-matrix, derivation of the time delay formula, the relation of the analytic structure of the S-matrix to effective range expansions, and derivation of Levinson's theorem and Swan's generalization when the target contains particles identical to the projectile. Numerous specific criticisms could be made of the chapter; nevertheless, it is of value to have all this material put together in a concise and convenient form.

Variational and bound principles are the subjects of chapter 8. The chapter also has a concise discussion of the R-matrix method, which is closer to the author's present research. The core of the method is a variational principle for the inner part of the total wave function. The discussion of bounds centers on the derivation of the upper bound expression for the scattering length. For positive energies, however, the book does not include the fundamental approach of Hahn and Spruch, Gailitis, and McKinley and Macek, an omission I believe to be unfortunate.

In the final two chapters the author comes to high energy methods. Here too I believe there are inaccuracies and omissions that cannot be justified by the brevity of the book. For example, no mention is made of the uncertainties concerning the convergence of the Born se-

ries in rearrangement collisions (including exchange). The definition of the Glauber approximation within the eikonal series is never really given; thus in the prescription of the recent Byron-Joachain eikonal Born series method one really does not know what f_{G_3} is.

One wonders for what audience the book is intended. As a book of self-study for the student, it is not sufficiently detailed or complete. It will be more useful as an outline accompanying a set of lectures, but it will rely heavily on the subsidiary material the lecturer will bring to bear. For the working scientist it will be a valuable guide, provided that he or she is aware of its selectivity and its several (but on the whole minor) shortcomings. I myself will be happy to have this book for reference.

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Hydromechanics of Swimming

Nekton. YU. G. ALEYEV. Junk, The Hague, 1977. vi, 436 pp., illus. Dfl. 120.

Functional-morphology ideas and observations from Eastern countries, particularly the U.S.S.R., are poorly incorporated into Western literature. Publications by Aleyev have been valuable to aquatic biologists, especially ichthyologists, in partly rectifying the situation. *Nekton* is no exception. If anything, the book should be more useful because Aleyev attempts to provide a broad, comprehensive account of adaptations for a particular way of life among animals from 12 classes. Within the limits of a single volume Aleyev succeeds in reaching his objective.

Nekton are animals in the water column capable of swimming at sustained speeds where inertial (pressure) forces dominate flow for fusiform fishlike bodies. The ratio of inertial forces to viscous (frictional) forces is traditionally expressed by Reynolds number (Re), which takes into account physical properties of water (viscosity, μ, and density, ρ), animal length, L, and velocity, V. Then $\mathrm{Re} = \rho LV/\mu$, and nekton are defined as those organisms for which $\mathrm{Re} > 5 \times 10^3$. Biologically, an increase in Reynolds number is associated with trends in body form away from adaptations to minimize sinking speed by maximizing hydrodynamic drag and trends toward adaptations to maximize swimming speed by minimizing locomotor drag. Typical nekton (eunekton) are further defined as swimming with $\mathrm{Re} > 10^5$ when flow in the entrained boundary layer tends to become turbulent. Aleyev believes these Re present the greatest problems in minimizing drag and the greatest potential for boundary layer control. In the Re range from 5×10^3 to 10^5 planktonekton are defined. Two additional nektonic types are defined in terms of their affinities for submerged surfaces (benthonekton) or land (xeronekton).

Fish dominate the nekton. Therefore the book serves partly to update Aleyev's *Function and Gross Morphology in Fish* (1963; English translation, National Technical Information Service TT67-51391, 1969). This work on fish provides the principles for a general study of convergent adaptations for nektonic life in representatives of Cephalopoda, Sagittoidea, Amphibia, Reptilia, Aves, Mammalia, and six classes of fishes. Crustacea are not mentioned, although portunid crabs can sustain speeds when $\mathrm{Re} > 10^5$ (Lochhead, in *Scale Effects in Animal Locomotion*, T. J. Pedley, Ed., Academic Press, 1977).

The definitions of nekton emphasize adaptations for swimming and drag reduction. Morphological adaptations for swimming are interpreted mainly through steady-state hydrodynamic theory for rigid bodies. In the United States and Britain, major advances in interpretation of body form and swimming have come through application of slender-body theory to swimming fishlike bodies. This approach emphasizes development of thrust and Froude efficiency and leads to some conclusions differing from those given by Aleyev. For example, Aleyev regards an eel as having a higher hydrodynamic swimming efficiency than a scombroid fish at sustained speeds because the eel has a relatively larger surface area. According to calculations of Lighthill (*J. Fluid Mech.* **44**, 265 [1970]) and Wu (*Adv. Appl. Math.* **11**, 1 [1971]), improved swimming efficiency might be expected with evolution of scombroid body form and locomotor movements. Most advances following from application of slender body theory to fish locomotion have come relatively recently, and the literature covering them is not discussed. Papers from Western sources more recent than 1971 do not appear to have been available to Aleyev during the preparation of the book. The most up-to-date source for this literature is Pedley's *Scale Effects in Animal Locomotion*, cited above.

Although adaptations for swimming and drag reduction are well represented, about 45 percent of the text discusses other adaptations, providing a well-rounded view of nekton as a group. Buoyancy control is discussed in detail. Adaptations for maneuvre, defense, camouflage, and senses are considered, as well as origins and geographic distribution of nekton. Principles established for extant forms are applied regularly to extinct animals. Changes in functional morphology during ontogeny are discussed in each chapter.

The book contains a wealth of data, primarily for morphological parameters, but Aleyev's coverage of Western literature is not much better than the usual Western coverage of Eastern literature. As a result, his account of observations sometimes becomes a catalogue from Russian sources, others being rejected. This is most apparent in the discussion of animal density. Only Aleyev's data and a few other Eastern sources are cited, the remainder being rejected on the grounds of differences in method. The basic method Aleyev describes for calculating density is from fish mass and volume, the latter measured by water displacement. The same or comparable methods are widely used in the rejected sources. Nevertheless, the data Aleyev presents are not readily available outside the U.S.S.R., and his book will be a valuable source for those working on the various groups of animals it deals with.

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Advances in Applied Mechanics. Vol. 17. Chia-Shun Yih, Ed. Academic Press, New York, 1977. viii, 390 pp., illus. $43.

Air Pollution Measurement Techniques. Proceedings of a conference, Gothenburg, Oct. 1976. World Meteorological Organization, Geneva, 1977 (U.S. distributor, Unipub, New York). xii, 224 pp., illus. Paper, $19. Special Environmental Report No. 10.

Algorithms for the Computation of Mathematical Functions. Yudell L. Luke. Academic Press, New York, 1977. xiv, 284 pp. $15.

Analysis of Species-Specific Molar Adaptations in Strepsirhine Primates. Daniel Seligsohn. Karger, Basel, 1977. viii, 116 pp., illus. Paper, $22.25.

Analytical Applications of NMR. D. E. Leyden and R. H. Cox. Wiley-Interscience, New York, 1977. xii, 456 pp., illus. $27.50. Chemical Analysis, vol. 48.

An Anatomy of Risk. William D. Rowe. Wiley-Interscience, New York, 1977. xiv, 488 pp., illus. $26.95. Wiley Series on Systems Engineering and Analysis.

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