Alfred Schneider is a professor in the School of Nuclear Engineering at the Georgia Institute of Technology. A chemical engineer by education, he has been active for 25 years in research, technical management, and education, primarily in the nuclear fuel cycle and energy conversion areas. He is currently a consultant to the New York State Energy Research and Development Authority and the U.S. Department of Energy.

Photochemistry of Small Molecules

Author Hideo Okabe

Publisher John Wiley and Sons, Inc.

Pages 431

Price $34.50

Reviewer G. K. Vemulapalli

Photochemistry is a subject with wide-ranging applications. Because of this, many books have been written that undertake to give comprehensive coverage of the subject. Most of these books concentrate on the photochemistry of relatively large molecules, about which a great deal of information is available to us. However, there are at least two good reasons for the investigation of the photochemistry of small molecules. In the first place, the connection between spectroscopy—absorption of light by molecules—and subsequent energy transfer, nonradioactive degradation, and reactivity is perhaps best studied in small molecules, since their quantum states are better characterized than those of the big molecules. Second, understanding of the photochemical processes in the small molecules may lead to technologically fruitful applications, e.g., isotope separation.

Okabe's book, *Photochemistry of Small Molecules*, is therefore a welcome addition to the photochemical literature. The book is well written with a balanced presentation of the necessary theory and a wide collection of applications. The author follows an overall organization similar to that found in Herzberg's classic monographs: description of the basic theory followed by detailed discussion of individual cases. This organization suits the subject very well and like Herzberg's books, this too should be a valuable resource for photochemists and spectroscopists.

The first chapter gives a concise description of spectroscopy; the second chapter describes the mechanisms of photodissociation and experimental techniques are covered in the third. Chapters 4 through 7 discuss the photochemistry of atoms, and diatomic, triatomic, and polyatomic molecules, while the last chapter briefly describes three topics related to photochemistry—isotope separation, photochemistry of planetary atmospheres, and air pollution.

The jacket states: "It is a particularly relevant text for graduate students, since no other book provides a comprehensive summary of the latest developments of photodissociation, dynamics, guiding principles of photodissociation, the relationship of photochemistry with spectroscopy and various recent topics related to photochemistry."

This is true to a large part. With supplementary material and problems, the book should serve as a textbook for graduate courses.

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Engineering for Nuclear Fuel Reprocessing

Author Justin T. Long

Publisher The American Nuclear Society (1978)

Pages 1025

Price $68.00

Reviewer J. A. Buckham

This is the second printing of the edition originally published in 1967. At that time it was the most comprehensive text ever written on the subject. Much of the information is of course timeless, such as the basic theory of solvent extraction and other diffusional and mass transfer operations. Unfortunately, in the past 13 years many technological advances have been made that are not covered. Even more unfortunate, nothing appears about a whole new area, licensing, which came about because of the change in political climate and public sentiment and which has a profound input on the entire nuclear industry. On this basis *Engineering for Nuclear Fuel Reprocessing* would still be useful in a beginning course in nuclear engineering, but would be of little value to an engineer involved in the design of an updated plant.

In the area of solvent extraction there are new and improved computer codes for approximating contactor operation, improved diluents, and new uranium-plutonium partitioning agents. Tributyl phosphate remains as the standard extractant, but the old kerosene-type diluents have been replaced by the saturated, straight-chain hydrocarbon, primarily a C_{12}-C_{14} cut. These diluents are subject to less radiation damage and nitration than the early diluents. Hydroxylamine nitrate has been studied as a partitioning agent for uranium and plutonium. Hydroxylamine has the advantage of eliminating the iron and sulfuric acid that would enter the high-level waste from the use of ferrous sulfamate. Electrolytic partitioning of uranium and plutonium has been developed in both Germany and the U.S. as a process improvement.

The sections on headend processing also need updating, particularly dissolution of spent fuel. Practically all the current light water reactor fuel is Zircaloy-clad UO_2, whereas the book discusses the older fuels, integral dissolution, etc. There is a long discussion of the Darex process,

which was never used outside the laboratory. This section could well be replaced with an upgraded discussion of shearing and dissolution of oxide fuels. The Nuclear Fuels Services plant sheared fuel, the La Hague plant shears fuel, and the Barnwell Nuclear Fuel Plant has an installed shear.

In the section on contactors, considerable space is devoted to out-of-date devices. This could be summarized and a discussion of the modern multistage centrifugal contactor included. The Robatel centrifugal contactor is in use in France and a similar ten-stage contactor is installed in the Barnwell plant.

On the subject of off-gas treatment, there are improved processes for iodine retention. These include the mercuric nitrate scrubber and the Iodox process. In the latter, the off-gas is contacted with hyperazeotropic nitric acid, which precipitates the iodine as a periodic acid. New solid adsorbers include silver zeolite developed in the U.S. and a silver-treated amorphous silica developed in Germany, both of which have excellent iodine retention properties.

The U.S. Environmental Protection Agency has mandated that ^{85}Kr generated in fuel irradiated after January 1, 1983 be subject to retention with an allowed release of 50 000 Ci/GWyr(electric). Thus, krypton capture merits updating. The fluorocarbon absorption process has been under development for many years. A cryogenic recovery plant has been operated on an intermittent basis in Idaho for years.

Waste treatment should be updated, in particular, the solidification of high-level waste (first extraction cycle raffinate). A considerable amount of research and development effort has been applied to high-level waste treatment in the last decade. The French have a completed process, calcination in a rotary kiln, blending the calcine with a glass frit and melting to glass. The glass is then cast in a metal container for final disposal. Modifications to the glass-making process are under development in the U.S. Aluminum- and zirconium-bearing wastes have been converted to a free-flowing solid in a fluidized bed calciner in Idaho. The solids are stored in bins, the result being a tenfold decrease in waste volume.

The application of computer technology has increased markedly since initial publication of the book. Besides the solvent extraction code mentioned above, there are new and improved isotope generation and depletion codes, ORIGEN for example, improved codes for criticality calculations, and new and improved codes for calculating shielding requirements. The use of small computers has resulted in a marked improvement in special materials accountability and timeliness of computing a material balance. Related to accountability are improvements in other instrumentation. For example, it is now possible to determine the contents of a 10 000-ℓ tank to within 6 ℓ.

The cost figures are archaic. In some cases the quoted costs are one to two orders of magnitude less than present-day costs. One factor besides inflation that has contributed to this rise is the change in quality assurance and regulatory requirements. These latter items are of utmost importance today.

Finally, the errors in the original printing should have been corrected: for example, in discussing the Purex process, one of the advantages cited was "*lesser* fire hazard because of the *lower* flash point of the solvent." Also, the symbol for curie has been changed from C to Ci since the first printing.

James A. Buckham (University of Washington), now Executive Vice President of Allied-General Nuclear Services, has worked in responsible positions in the nuclear fuel processing field for over 25 years. He spent some 22 years at the Idaho Chemical Processing Plant, which he left in 1976 after having advanced to the position of Assistant General Manager. Dr. Buckham has long been active in the American Nuclear Society and the American Institute of Chemical Engineers (AIChE), in which he was recently elected to a three-year term as director. He formerly served AIChE as National Program Chairman and Chairman of the Nuclear Division, and was awarded its Robert E. Wilson Award in 1974 for excellence in nuclear chemical engineering.