Book Reviews

Technetium: Chemistry and Radiopharmaceutical Applications. By K. Schwochau (Forschungszentrum Jülich, Germany). Wiley-VCH: Weinheim. 2000. xii + 446 pp. DM 348. ISBN: 3-527-29496-1.

Technetium, element 43, is the radioelement of lowest atomic number for which no stable nonradioactive isotopes exist. The isotope ^{99m}Tc (gamma energy = 142 keV, $t_{1/2}$ = 6.02 h) has ideal properties for diagnostic imaging using SPECT and is the most widely used isotope in nuclear medicine. These unique properties, as well as the fundamental chemistry of technetium, are explored in this very useful handbook. The chapters are comprehensive, well-organized, and very well referenced. The author makes good use of tables to collect pertinent information, and important experiments are succinctly described.

The book is divided into two sections. The Chemistry Section is the most extensive and well-referenced and is organized into 12 chapters. The first two provide interesting information on the separation of Tc from Re, its third row congener, and the isolation of Tc. Chapter 3, "Natural Occurrence", discusses ^{99}Tc found in the earth's crust, where it is predominantly formed by fission of ^{238}U and also by neutron-induced fission of ^{235}U. Chapter 4, "Artificial Occurrence", covers technetium in the nuclear fuel cycle, which is responsible for providing most of the ^{99}Tc in the environment. Environmental concerns about the solubility and mobility of TcO_4^- in aquatic systems, the retention of pertechnetate in soils, sediments, and rocks, as well as its accumulation in plants, microorganisms, animals, and the atmosphere are also addressed. Extraction of pertechnetate by solvent extraction techniques is discussed and referenced, and many important parameters, such as uptake, distribution coefficients, and concentration factors, are accurately reported in the text and in tables. In Chapter 5, the author summarizes, in a chart, the isotopes of technetium and focuses on the production, isolation, and nuclear properties of ^{99}Tc as well as the handling of technetium nuclides. Licensing limits, intake limits, and maximum permitted air concentration of Tc nuclides are also included in the tables.

The fundamentals of technetium chemistry are the focus of Chapter 6, which covers the electrochemistry, thermodynamic data and stability, and reactivity of technetium and provides comparisons with rhenium. Analytical methods to detect, separate, and determine Tc accurately, which are critical to the development of Tc chemistry, are covered in Chapter 7. Some of the techniques that are discussed include radiometric methods, spectrometry, and a variety of mass spectrometric techniques. Simple spectrophotometric techniques, as well as gravimetry and electrochemical methods for the determination of the concentration of ^{99}Tc at microgram and lower levels, are also reviewed, as are separation methods for TcO_4^-.

In Chapter 8, the author explores some of the possible applications for ^{99}Tc, including experiments to examine the potential of ^{99}Tc complexes as catalysts and the excellent corrosion inhibition properties of ^{99}Tc, whereas in Chapter 9, there is a discussion of the preparation and the physical and chemical properties of technetium metal and its intermetallic compounds and alloys. A well-referenced table that lists the phase composition, structure, and lattice constants of the intermetallic compounds and alloys of technetium is provided. In Chapter 10, the author presents a brief but thorough treatment of the binary compounds of technetium, including oxides and halides. Again, key compounds and data are summarized in tables. Hydrides, borides, carbides, nitrides, phosphides, arsenides, oxides, halides, and oxide halides are covered, and structures of selected compounds are illustrated.

The oxotechnetates are examined in Chapter 11. This chapter covers the synthesis and properties of pertechnetic acid, pertechnetic acid salts, oxotechnetate(VI), the ternary and quaternary oxides of technetium, and the characterization of the pertechnetate ion. Key physical data are presented in well-referenced tables and compared to analogous rhenium compounds.

Chapter 12 is the most extensive chapter in the book. In this very comprehensive chapter, the author summarizes the many ^{99}Tc coordination and organometallic complexes that have been prepared and characterized through the late 1990s. This chapter is organized into sections, by oxidation states, from Tc(VII) to Tc(−I). Each oxidation state is further organized by the ligand donor atoms, and illustrations are given of key complexes. Much data, such as crystallography data, and other characterization data (color, IR, Raman, magnetic moment, $E_{1/2}$, NMR, and melting point data) are collected into tables. This chapter also provides interesting, brief discussions of the reaction chemistry of many ^{99}Tc complexes and provides comparisons with the analogous rhenium complexes.

The second section of the book is entitled "^{99m}Tc Radiopharmaceutical Applications" and is organized into seven sections. Sections 1−5 feature the titles "Introduction", "Generation of ^{99m}Tc", "Imaging of Organs", "Synthesis Aspects and Requirements", and "Radiopharmaceutical Kits". In these sections, the author succinctly reviews the background material necessary to understand the technetium chemistry pertinent to radiopharmaceutical applications. In Section 6, is a discussion of the synthesis, structure, and development of ^{99m}Tc radiopharmaceuticals. In this section, various imaging agents, such as those used for brain perfusion, myocardial perfusion, hepatobiliary and renal systems, bones, ^{99m}Tc-labeled red and white blood cells, and tumors, are discussed. The future prospects of such radiopharmaceuticals as functionalized D-glucose-labeled ^{99m}Tc and novel myocardial imaging agents based on the ^{99m}Tc(V) nitrido core and organometallic ^{99m}Tc(I) cores, as well as hypoxic tissue imaging agents, receptor binding agents (peptide and non-peptide molecules), and dopamine transporter imaging agents are also explored. Section 7 of Part B contains a table summarizing the ^{99m}Tc radiopharmaceuticals.

This book should be useful to the radiopharmaceutical chemist, because the coverage of pertinent coordination complexes and recent developments in the field is excellent, and the references are reasonably current. Some of the latest data on ^{99m} Tc radiopharmaceuticals, for example, some of the new peptide receptor products, have not been included in this book, but the section on Radiopharmaceutical Applications nevertheless gives an excellent overview of the field and the direction of current research. Because the focus of the book is on technetium chemistry applied to radiopharmaceutical use, coverage of studies that concern ^{99}Tc radioactive waste remediation, such as extraction from radioactive waste and studies on proposed storage matrixes, are beyond the scope of the book; however, this book should still be useful to chemists and geochemists who are interested in some of the problems associated with ^{99}Tc in the environment, especially issues of identification of ^{99}Tc species and separation of ^{99}Tc in radioactive waste tanks and waste streams, because the fundamental chemistry, coordination chemistry, and reaction chemistry of technetium is covered thoroughly. Overall, the language is clear, and the illustrations and tables provide pertinent information in a succinct fashion.

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