BOOK REVIEWS

Methods and Styles in the Development of Chemistry. Joseph S. Fruton, American Philosophical Society, Philadelphia, PA, 2002; xviii + 332 pp, Cloth, ISBN 0-87169-245-7; $40.

Winner of the 1993 Dexter Award in the History of Chemistry, Dr. Fruton is best known for his work on the history of biochemistry and, more recently, for his essays and autobiography. This small, attractive volume represents his first venture into the general history of chemistry and is very much in the tradition of the well-known short histories of chemistry by Partington and Leicester, both of which are still available as quality Dover paperbacks. Like its predecessors, the book tends to emphasize the lives of famous chemists and, like them, its coverage of 20th-century developments after 1925 is minimal at best. However, Dr. Fruton has a lighter, more discursive writing style, which makes his book a much better read, and has availed himself of much of the recent secondary literature in the history of chemistry, as is apparent from the excellent notes appended to the end of the book.

The book is divided into ten chapters which are thematic in content but also roughly chronological in terms of when the topics in question became historically important. Protochemistry is covered in the first chapter under the title "The Greek Inheritance and Alchemy," followed by two chapters dealing with the 17th and 18th centuries ("Chemical Composition and Phlogiston" and "Antoine Lavoisier"), five dealing with 19th-century developments ("Atoms, Equivalents, and Elements;" "Radicals and Types;" "Valence and Molecular Structure;" "Stereochemistry and Organic Synthesis;" and "Forces, Equilibria, and Rates"), one dealing with the 20th century ("Electrons, Reaction Mechanisms, and Organic Synthesis"), and a final "Conclusion." I would strongly recommend this book as a possible text for a one-quarter or one-semester history of chemistry course directed at chemistry majors. That said, however, there are also some caveats to that recommendation, though I am loath to place the responsibility for these solely on Dr. Fruton and suspect that many of them are due to the publisher and editors since they apply equally well to much of the recent literature in the field.

The first deals with the book's title. There was a time when academic books had honest titles which succinctly summarized their contents and intended use, such as "A Short History of Chemistry", "An Introductory History of Chemistry", etc., but starting in the 1970s it became fashionable to base titles either on catchy "in the know" phrases (e.g., "Atoms and Powers") or grandiose higher historical or cultural themes (e.g., "Enlightenment Science in the Romantic Era") with only the subtitles following the colon giving any real concrete information about the book's actual contents. Though Dr. Fruton has been a keen critic of much of this historical silliness, as witnessed by his essays and the conclusion to the book under review, he nevertheless appears to have fallen into this trap himself. The title "Methods and Styles in the History of Chemistry" surely suggests a special emphasis on instrumental and procedural innovations (methods) and a detailed study of each scientist's published works in order to identify philosophical choices, favored approaches to problem solving, preferences for certain types of experimental or theoretical argument, etc. (style). But nothing of this sort is apparent in this book beyond a general discussion of this topic in the forward. As already pointed out, the special emphasis, if any, is biographical; and Fruton appears to use the term "style" in a highly idiosyncratic manner to denote what is, in reality, nothing more than a summary of a given chemist's research accomplishments.

A second criticism deals with the illustrations. In scientific writing illustrations are highly integrated with the text and serve to clarify difficult points. In contrast to histories of chemistry written by chemists, those writ-

ten by historians are notable for their lack of illustrations. Though this has improved somewhat in recent years, one receives the impression that many of the illustrations used in their books have been added as a decorative afterthought; and the same appears to be the case with some of the illustrations in this book, few of which are discussed in any substantive manner within the body of the text or in the captions. Thus, though an entire chapter is devoted to chemical types, not a single type formula is illustrated, while an entire page is consumed in showing Faraday's apparatus for the measurement of electromagnetic rotation, a topic of little relevance to the history of chemistry.

A third criticism has to do with equations and formulas. According to historians, chemists who write about history of chemistry are usually guilty of two sins: whiggism and writing for other chemists. Though common sense would dictate that chemists are the most logical audience for books dealing with the history of chemistry, said historians have managed to delude themselves and their publishers into believing that there is a vast nonchemical audience for books of this type. Two unforeseen consequences of this delusion appear to be the assumptions that the use of chemical formulas and mathematical equations must be kept to an absolute minimum (and preferably banished to an appendix if possible) and that it is unnecessary to have a qualified chemist read the manuscript before publication. The result has been a proliferation of an embarrassing number of elementary chemical errors in recent history of chemistry publications. Examples include John Servos' definition of a reaction rate, in his otherwise excellent history of American physical chemistry community, as the change in concentration with respect to temperature (instead of time), and Elisabeth Crawford's painful page-long attempt, in her otherwise outstanding biography of Arrhenius, to verbally describe the factors involved in measuring the conductivity of an electrolyte solution, when reproduction of the appropriate equation would have made all instantaneously obvious.

The appearance of similar errors in Dr. Fruton's book is more puzzling since he is both an outstanding chemist and historian and, to judge from his acknowledgments, had various chemists review at least some portions of his manuscript. But they are there in abundance, especially in the chapter on "Forces, Equilibria and Rates," where the publisher has chosen to set the equations within the body of written text, rather than setting each on a separate line for proper emphasis, as is universally done in the technical and mathematical literature. Thus van't Hoff's isochore is incorrectly given (p. 176) as:

$$d\ln K/dT = \Delta \ln U/RT^2 \text{ instead of } d\ln K/dT = \Delta H/RT^2$$

The Arrhenius equation is incorrectly given (p. 176) as:

$$\ln k = Ae^{-E/RT} \text{ instead of } k = Ae^{-E/RT}$$

and the Nernst equation (written for some reason for a concentration cell rather than for a redox couple) is incorrectly given (p. 183) as

$$E = (RT/N)F\ln(C_1/C_2) \text{ instead of } E = (RT/NF)\ln(C_1/C_2)$$

Likewise on pages 173-174, Gibbs' equation from his 1873 memoir on graphical methods for the thermodynamics of fluids:

$$d\varepsilon = td\mu - pdv$$

is both incorrectly reproduced (Gibbs used η rather than μ for entropy) and incorrectly identified with his later free-energy equation:

$$\Delta G = \Delta H - T\Delta S$$

when in fact it is Gibbs' expansion of the equation for the first law of thermodynamics:

$$\Delta U = \Delta Q + \Delta W = T\Delta S - P\Delta V$$

and the free-energy equation does not appear until Gibbs' later memoir on the equilibrium of heterogeneous substances, where it is given in his notation as:

$$\zeta = \varepsilon - t\eta + pv$$

Finally, free-energy is represented as both ΔG and ΔF at various points in the chapter without explicit mention of the change in notation and E is used to symbolize both activation energy and electrochemical potential, also without comment.

A final criticism involves the coverage of 20th-century chemistry. As noted earlier, the short histories by Partington and Leicester have little to say about 20th-century events beyond the establishment of Bohr's model of the atom and early radiochemistry. Fruton does slightly better as he not only discusses these events, but also early electronic bonding models and the rise of physical organic chemistry to about 1966. However, nothing is said about colloid and surface chemistry, modern solid-state and inorganic chemistry, quantum statistical mechanics, or developments in the field of analytical chemistry.

Nevertheless, once these criticisms and limitations are apparent, it is easy enough for a teacher to provide the necessary corrections and supplements, and I stand by my earlier recommendation of this book. Indeed, I would rate it, along with Bill Brock's 1992 history, as one of the best short histories to appear in the last 40 years. *William B. Jensen, Department of Chemistry, University of Cincinnati, Cincinnati, OH 45221-0173.*

The German Chemical Industry in the Twentieth Century. John E. Lesch, Ed., Kluwer Academic Publishers, Dordrecht, Boston, London, 2000, viii + 449 pp. Hardcover. ISBN 0-7923-6487-2. Euro 163.50; $176.

This book, Volume 18 in the "Chemists and Chemistry" series from Kluwer, is a collection of 14 papers from a conference held at Berkeley, CA in March 1997. In the introduction by the editor, Department of History at Berkeley, the three themes of the volume are enumerated: research and development, impact abroad, and an account of the German chemical industry since 1945. Except for a short chapter on "I.G. Farben Revisited," the chapters are presented in Parts I-III according to the three themes. The first two papers in Part I—"Research and Technological Innovation"—by J. A. Johnson and D. Stoltzenberg (the recent Haber biographer) provide insightful descriptions of the effective research programs in the German chemical industry, with emphasis on the academic-industrial symbiosis in the period 1903-1939 and the particular roles played by Emil Fischer and Carl Duisberg. The impact of World War I is described here and also in the following paper by M. Szöllöse-Janze, "Losing the War but Gaining Ground: The German Chemical Industry during World War I." In the following chapter by P. Löhnert and M. Gill, the handling of Jewish scientists and those married to Jews at I.G. Farben's Agfa Filmfabrik Wolfen in the 1930s is documented. A. N. Stranges describes Germany's synthetic fuel industry, 1930-1945, in the last paper in Part I.

The four papers in Part II deal with the interaction of Germany chemical industry with Great Britain, Japan, and the United States. U. Marsch makes a case for the development of a strong British chemical industry, with the German's as model. This included formation of British Dyestuffs Ltd., founding of numerous research associations (modeled after the Kaiser-Wilhelm Institutes), and initiation of governmental financial support for industry. A. Kudo describes the opening in Japan of operations in dyestuffs, ammonia, and synthetic oil by I. G. Farben in the 1920s and 1930s. For this reviewer, one of the most revealing accounts is found in the paper by M. Wilkins, "German Chemical Firms in the United States from the late Nineteenth Century to the post-World Ware II Period." Here the reader can follow the fate of German firms established in the U.S. before World War I, their demise, and rejuvenation after 1945. The Bayer aspirin saga is an especially dramatic example. These international negotiations between the two world wars are further explored by K. Steen from the political point of view in the final paper in Part II.

Part III, "The Industry since 1945," is made up of four papers by social scientists. In the first, the legacy of anti-Semitism is treated by means of the Richard Willstätter controversy. The second covers the often short-sighted and selfish handling by the Soviets of chemical industry in East Germany after 1945. Next comes an overview of developments in chemical industry in the 1980s in the U.S., Japan, and Western Europe (not limited to Germany). The final chapter by R. Stokes provides an overview of the conference and poses the question as to what additional research remains for historians of the German chemical industry in the 20th century.

The authors have consistently substantiated their presentations with documentation in the form of lists and tables. While this strengthens the narrative, it makes for heavy reading. (This reviewer managed to get through the book over the period of a year.) Yet the volume is a valuable resource for anyone who seeks an overview of the evolution of the Germany chemical industry. Chemists will probably find less compelling those papers dealing with social, economic, and political impact. This reader was gratified by the straightforward account of Emil Fischer's suicide (p 87), so often overlooked or even denied. Inevitably one finds overlap and repetition of some aspects of the subject from