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Book Review

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Industrial catalysis: a practical approach

Wiley-VCH, 2006, 2nd edn,
525 pp; price £115.00/€172.50
ISBN 978-3-527-31144-6 (hardcover)

Hagen's book is an up-to-date account of industrial catalysis. Based on a lecture course for chemical engineers, it is aimed at 'both the student and the experienced practitioner'. It is intended to be 'useful both to students who have studied chemistry or chemical engineering and to graduates and chemists who work in or are interested in the chemical industry'. The book is claimed to be 'particularly well suited to studying on one's own'—helped by well-constructed and graded exercises (with answers) which both test and extend the reader's knowledge and understanding. The aims and intentions are, on the whole, fulfilled.

The coverage, for a single author volume, is impressively wide: homogeneous catalysis, heterogeneous catalysis, electrocatalysis, photocatalysis, phase transfer catalysis, biocatalysis and catalysis in environmental and green chemistry. There are chapters on catalyst development and testing including kinetic modelling and simulation, catalytic reactors, the economic importance of catalysis in chemical technology and pollution control and a concluding chapter which looks to future demands and challenges (for example, using catalysis to exploit CO_2 as a feedstock instead of burying it). The emphasis, as to be expected from the title, is on applied catalysis in chemicals manufacture and industrial processes. There is a wealth of information on technical catalysts and their applications. The chapters on less familiar topics (biocatalysis, photocatalysis) are a useful introduction. The chapter on electrocatalysis successfully relates heterogeneous and electrode catalysis and includes a discussion of fuel cell catalysts. The complexity of technical catalysts is brought out: see, for example, the historical account of additives ('promoters') in the bismuth molybdate propene-to- acrolein selective oxidation catalyst. The coverage of catalysts and their applications is comprehensive and up to date.

For organometallic chemists the chapters on homogeneous catalysis with transition metal catalysts and homogeneously catalysed industrial processes will be of particular interest. Applications described are the Oxo synthesis, carbonylation of methanol to acetic acid, ethene oxidation by the Wacker Process, cyclohexane oxidation, ethene oligomerization and olefin polymerization, and asymmetric catalysis in drugs and fine chemicals synthesis.

The fundamental principles of catalysis are presented in the chapters on homogeneous and heterogeneous catalysis. The emphasis is on trends in binding and activation of reactant molecules in relation to their structures (saturated or unsaturated) and to the properties of the catalyst, in particular to the position of the catalytic element in the Periodic Table and its electronic and steric structure, and the principles of catalyst selection. Solid-state and surface chemistry concepts are covered.

The material is clearly presented in short sentences and short paragraphs in continuous prose with a welcome absence of distracting boxes and garish colour. Diagrams are mostly well presented, although some graphs suffer from what appear to be hand-drawn wobbly lines. Figures would have benefited from expanded explanatory captions and so would table headings. I liked the inclusion of photographs of, for example, test reactors and industrial chemical plant; they would have been improved by text box labelling of components.

Unfortunately, while my general opinion of the book is favourable, I have a number of criticisms which, should certainly be addressed in any future edition. The beginning student will be confused by statements which are dubious to say the least: 'fastest dissociation' is *not* 'demonstrated by the dissociation constants for complexes'; and cyclododecatriene nickel is *not* an example of a 'transition metal [having] the electron configuration of the next higher noble gas'. Are partially filled *d*-orbitals really 'responsible for the covalent binding of gases on metal surfaces in chemisorption and catalysis'? I found by chance a paragraph on $CoMo/Al_2O_3$ hydrodesulfurization catalysts in a section on promoters indexed under 'promoter—Co'; molybdenum disulfide, the active component of the catalyst, is not indexed, and the page references to hydrodesulfurization are incidental. The index is poor, although finding one's way around the book *is* helped by a detailed table of contents; a layout with distinctive type faces and indents for subsection headings would have been helpful. There are a surprising number of typographical errors—indicative of a degree of carelessness not expected from a well-regarded international publisher.

Finally: is it too much to expect a scientific publication today to adhere to IUPAC conventions? To include units in definitions of symbols of physical quantities and in equations is not good practice and might well cause confusion and error: for example, to define S in a table of symbols as 'surface area [m^2/kg]' and then to have in the text units m^2/g; to define r as 'reaction rate [mol L^{-1} h^{-1}]' and then to have in the text a rate equation with units kmol kg m^{-2} s^{-1}. Numerical values in tables and graphs suffer from ambiguities which I hoped had long since been overcome by the use of quantity calculus. To take one example, and there are many, the rate of hydrogenolysis of ethane over a Ni/SiO_2 catalyst is tabulated as 151 in a column headed reaction rate [mol m^{-2} metal $h^{-1} \cdot 10^6$]: I suspect the numerical value of the rate is 151×10^{-6}, although the way the units are given implies 151×10^6, greater by a factor of 10^{12}!

Nevertheless, to conclude: I found the book accessible, readable and interesting—both as a refresher and as an introduction to new topics—and a convenient first reference on current industrial catalytic practice and processes. Hagen's book should be in the catalysis section of academic and institutional libraries, and the more affluent teachers and practitioners will find it worth having on their shelves.

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