The Platinum Metals in Catalysis

Heterogeneous Catalysis in Practice By CHARLES N. SATTERFIELD, McGraw-Hill Book Company, New York, 1980, 416 pages, $26.95

This book was written to provide an overview of the vast interdisciplinary science defined by the title, and especially to provide an introduction to the science. Emphasis is placed primarily on catalysts and reactions that are of industrial significance, the treatment given is realistic and practical and there is sufficient theory for the subject to be rationalised and understood without going into excessive detail and speculation. It aims to give an appreciation of the subject for work with solid catalysts in the laboratory, pilot plant or commercial installation.

The opening chapter classifies catalysis in terms of geometric, electronic and chemical concepts. It then reviews development of all the major industrial catalytic processes from the early use of platinum to convert sulphur dioxide to the trioxide, up to the more recent petroleum reforming reactions and pollution control systems. It is immediately apparent that platinum metals are playing a prominent role in industrial heterogeneous catalysis. Applications range from the use of 10 per cent rhodium-platinum gauze for ammonia oxidation and hydrogen cyanide production to the hydrocracking, using palladium on zeolite, and the reforming of hydrocarbons over platinum, platinum-rhenium or platinum-iridium on acidified alumina.

Other uses for the platinum metals include palladium on carbon catalysts in slurry reactors for hydrogenation of unsaturated organics and palladium on an acid resistant support for the oxidation of ethylene to acetic acid and vinyl acetate. Palladium supported on alumina is used for selective hydrogenation of acetylene in ethylene streams. An important use for platinum metals catalysts on pellets or monoliths is in emission control from car exhausts; and the use of platinum systems for the removal of nitrogen oxides and hydrocarbons, discharged from nitric acid and food processing plants, respectively, are also described later in the book. Catalytic combustion promoted by platinum catalysts may soon also play a role in primary energy production via gas turbines—here the process is initiated by the catalyst and completed by free radical chain reactions in the gas phase to give very low emissions.

Although the book is primarily on heterogeneous catalysis, it also includes a discussion of important commercial homogeneous processes such as the hydroformylation of olefins, conversion of methanol to acetic acid and the oxidation of ethylene to acetaldehyde, all of which are advantageously catalysed by soluble platinum metals catalysts—the first two by rhodium and the third by a redox Pd^{0}/Cu^{II} system. Reasons for preferring homogeneous to heterogeneous processes in these cases are analysed.

After defining the basic concepts involved in catalysis the book goes on to consider adsorption and kinetic models for reactions. Catalyst manufacture and physical characterisation are described, as are the varieties of support and their influence on applications and products.

Two substantial chapters on the processing of petroleum fractions by cracking, reforming, isomerisation and hydrodesulphurisation, and synthesis gas chemistry, including ammonia and methanol synthesis, are particularly helpful.

Useful reference lists are given at the end of each chapter, and the Appendix contains comprehensive lists of relevant books and articles.

Overall, Professor Satterfield has drawn from his wide experience as a teacher and practitioner in Applied Catalysis to write a very readable, authoritative, instructive and up-to-date introductory text which can be recommended for people from a wide range of disciplines who wish to get a good grounding in catalysis and to appreciate the importance of the platinum metals within this field. D.T.T.