Liquid Metals Chemistry and Physics, Sylvan Z. Beer, (ed.), Marcel Dekker, New York (1972). 731 pages. $35.00.

This book is aimed at a comprehensive review of the status of the subject matter which is just approaching maturity. As the editor states articles are presented largely in the form of summaries of the work done. However, they were written with the intent of combining reviews with original contributions and critical comments on various selected aspects of a very large field. Chemical engineers in general should be aware that this book is not a source of engineering data on liquid metals but a collection of subjects providing basic formalism and theory of metals and metallic alloys, predominately from the viewpoints of material scientists and physicists. It should become obvious that this book is different from the *Liquid Metals Handbook*. For similar reasons, there is no preferential treatment given to the alkali metals. (This remark is for those who might think that alkali metals and liquid metals were synonymous.)

A total of 15 chapters are presented, covering the subject of thermodynamic formalism, kinetics of evaporation, electric and optical properties, surface tension and viscosity, structure theory, diffraction analysis, sound propagation, magnetic properties, pressure effects, diffusion, electromigration, electronic nature and liquid metal theory, and noncrystalline metallic alloys. It embodies information useful to workers in a variety of fields such as air pollution, boiling liquid metals, magnetohydrodynamics, as well as diffraction and electromagnetic theories, general theory of susceptibility of metals, and pseudo potential theory of metals. With such a wide scope, it is difficult to expect that all areas could be treated with the same degree of thoroughness. This reviewer finds that the discussions of the relation between thermodynamic and electrical properties of liquid alloys and the kinetics of evaporation of various elements from liquid iron alloys under vacuum are quite interesting and comprehensive. On the other hand, this book also reveals areas that considerable development is still wanted, such as the diffusion phenomenon in liquid metals. The particular chapter on this subject is disappointingly short. Information on diffusion coefficients are often hard to find, but no suggestion in this respect is offered. In the overall arrangement of the book, it is commendable that amazingly little repetition exists despite the fact that different authors contribute to various chapters. One drawback, however, of the book appears to be the lack of nomenclature in each chapter.

Finally, a few statistics may be of interest. The source of information is so broad that many articles were originally published in foreign periodicals: 16% of references from UK, 10% from Russia, 14% from the rest of Europe, 3% from Asia, and the balance (57%) from the United States. In this broad collection of the related references, the growth rate of the literature in this field is also noteworthy: 28% of the references were published within the last five years, 34% between 1962 and 1967, and 38% a decade or more ago.

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Physical Principles of Chemical Engineering, Peter Grassman, Pergamon Press, New York (1971). 896 pages. $48.00.

According to the author, this book is intended for physicists, physical chemists, and mechanical engineers, as well as chemical engineers. Its purpose is to provide a foundation on which they can all continue to build. The book, which is written at roughly the level of an upperclass engineering text, is a blend of basic ideas and techniques and the analysis of industrial equipment. While a knowledge of thermodynamics is assumed, a chapter on the concept and use of entropy is included.

There are chapters on standard chemical engineering topics such as principles of fluid dynamics, applications of fluid dynamics, heat, mass and momentum transport and rheology. The approach frequently relies on dimensional analysis and model theory, and a chapter on these topics is included. The equations of change are adequately presented and discussed; however, they do not occupy the central and unifying position that they do in the books by, for example, Bird, et al. or Slattery. On the other hand, many complex phenomena such as water hammer and bubble formation frequently ignored in basic works are considered.

The kinetic theory of gases and physics of solids are covered in two well-written chapters. Most chemical engineers will find the material on stress distributions and deformation of solids especially interesting and informative.

There are also chapters on materials with large surface area and multiphase flow. These are probably the most valuable parts of the book. The material is treated in a very general manner with helpful surveys at the beginnings of the chapters. Here, as in much of the book, the results of a great many investigators are presented and woven together to provide a description which extends from the basic concepts to the very complicated and largely empirical.

The final chapter (12) is intended as a summary. In actuality, a new series of topics ranging from reactor stability to theoretical plates to optimization are briefly examined. The material builds on the preceding portions of the book only in the sense that the concepts of heat and mass transfer, etc., are used.

Obviously the author has set an enormous task for himself. He has succeeded best at the extremes of the very basic, for example, kinetic theory of gases, and in those areas where exact analysis is difficult, atomization, for example. Anyone reading the book has to be impressed by the magnitude of the effort and the knowledge displayed. The author states in the preface that books should be written by a single individual. This one certainly was. At no place does one get the feeling that he is getting the standard treatment of a topic. Despite the size of the volume and the breadth of the coverage, the treatment is remarkably uniform. In summary, though the principles of transport phenomena are not as simply presented as they can be, the book frequently provides an alternative approach and occasionally real insight into complex phenomena.

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Catalysis Reviews, Vol. 6, H. Heinemann, Ed., Marcel Dekker, Inc., New York (1972). 341 pages. $19.50.

How does one review a book of reviews? This question needs an answer before we proceed. When I began reading this excellent compilation of research reviews I wondered who would study the entire book besides the editor and me. When I finished I was convinced that the breadth and quality of the papers was such that any newcomer to the field of catalysis would do well to read the book rather than selected portions. It would provide an excellent discussion base for a graduate seminar in catalysis; with this in mind the present review will address the individual papers in a different order than they appear in the book.

Two papers discuss the homogeneous catalysis of the *oxo* reaction. M. Orchin and W. Rupilius review the

"Mechanism of the Oxo Reaction." They have sorted the various aspects of the complex history of hydroformylation chemistry admirably. Most of the useful tools of homogeneous catalysis are demonstrated, from molecular orbital theory to empirical kinetics to stereochemistry. The value of the stoichiometric reaction in the overall understanding of the catalytic *oxo* process is well documented. This paper nicely precedes the study of F. Paulik's review of "Recent Developments in Hydroformylation Catalysis." The combination of these two papers provides a thorough consideration of most aspects of homogeneous catalysis within the framework of a single system of process chemistry. Paulik discusses not only the most recent catalyst systems but also the effect of various process variables on the reaction system performance. His paper is concluded by briefly describing the performance of modified homogeneous catalysts which are mounted on porous solid supports.

The paper by R. J. Kokes entitled "Some Aspects of Catalysis: The P. H. Emmet Award Address" provides an excellent discussion of much of his own work in the hydrogenation of ethylene, the isomerization of olefins, and the oxidation of hydrocarbons. This is good recommended reading for anyone interested in heterogeneous catalysis. After reading Koke's paper the review of "Electron Localization and Oxygen Transfer Reactions of Zinc Oxide" by P. Roussel and S. J. Teichner provides a very effective transition from primary concern with the surface reaction to increased attention to the manner of surface involvement in the reaction. Many of the techniques described in these two papers are similar, and for students this reinforcement is helpful. Along similar lines the "Study of Kinetic Structure Using Marked Atoms" by John Happel develops the utility of isotopic tracer techniques along with the stoichiometric number concept of Horiuti in analyzing complex catalytic reaction systems. He reviews theory and experiments and then discusses the application of these tools to the ammonia synthesis, sulfur dioxide oxidation, carbon monoxide oxidation, and the dehydrogenation-hydrogenation of C_4 hydrocarbons.

Surface and support properties are considered in two papers. The first is by R. J. Cvetanovic and Y. Amenomiya, "A Temperature Programmed Desorption Technique for Investigation of Practical Catalysts." This experimental method, the apparatus and procedure, and the results for some typical systems are described. The authors anticipate that one of the principal uses of this technique will be in obtaining information on the energetic heterogeneity of catalytic surfaces. The second paper in this area is "X-ray Scattering Techniques in the Study of Amorphous Catalysts" by P. Ratnasamy and A. J. Leonard. They discuss the radial electron distribution method and the interpretation of results in application to various catalyst supports.

In conclusion, the reader can turn to the very timely discussion of Frank Dwyer on "Catalysis for Control of Automotive Emissions." He reviews in a most convincing manner the current status in each of the various aspects of this problem. Where answers are currently unavailable he points this out. He considers the requirements and difficulties in each area and concludes that there "seem to be no published claims for catalysts that will survive 50,000 miles of use when the 1975 Federal standards are used as the criteria." Recalling our fictitious graduate student in his catalysis seminar, this conclusion should send him back to the laboratory with real problems to solve and much better prepared to tackle them for having invested the energy required to study this volume of Catalysis Reviews.

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Industrial Crystallisation from Solutions, Jaroslav Nyvlt. Transl. by Paul Feltham, Butterworth & Co., Ltd., London (1971). 189 pages. $28.70.

This slim book first published in Czechoslovakia in 1967 has been extensively revised for this first English edition. It should prove interesting and useful to the chemical engineer and others who have to deal with the practical problems of crystallization from solution.

The author has tried to provide a ready reference and handbook to the practical aspects of industrial crystallization and has done a good job in the attempt.

Arranged in only two chapters, it covers Theoretical Foundations of Crystallization and Design Calculations for Crystallizer Installation.

While this may seem short for a book, each chapter is divided into numerous subdivisions. Chapter 1, while not as detailed as material to be found in other monographs, gives a good background in crystallization. Some of the topics covered are phase equilibria, material and thermal balances, equilibrium diagrams, correlation methods for solubilities in multicomponent systems, kinetics of crystal growth, kinetics of crystallization, kinetics of nucleation, crystal habit, product purity, and product size distribution. Chapter 2 switches to the more practical aspects of crystallization covering various types and designs of crystallizers that are to be found in industrial practice. These cover stirred-batch and -continuous crystallizers, series stirred, classifying and parallel-flow crystallizers, among others. Also covered are some types which are not normally found in U.S. industry.

Numerous examples, tables, and hints throughout add to the book's usefulness. Background equations are given along with a clear explanation without trying to go into detailed theory on each subject. References are given for those wishing a more theoretical discussion of the subjects.

Indeed, an outstanding feature is the profusion of references given throughout the book. Each subdivision has its own reference list of from 2 to 265 entries, and there also is an additional list of over 400 entries in regard to crystallization of various compounds listed in the appendix. A large number of these entries are 1968 or later, up to and including 1971.

While other well-known monographs exist on crystallization (Mullin, 1961; Van Hook, 1961; Bamforth, 1965), this book does not compete with but rather complements them. It was not intended to be an all-inclusive work and should not be considered as such. The author has done a very good job from the chemical engineering standpoint, and this book should find its place on the shelf of all those who are engaged in this field.

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Detergency: Theory and Test Methods, W. G. Cutler and R. C. Davis, (eds.), Marcel Dekker, New York (1972). 451 pages. $28.50.

Is detergency significant to the chemical engineer? Of course his clothing, dishes, automobile, hair (if any) and skin are washed more or less frequently. Probably, however, he concerns himself less over these than about

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