

## BOOKS

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paid to United States crystallization literature, as the model used to relate growth and crystal size was shown to be inadequate by Larson and coworkers. Bransom does show that growth rate for  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  is linearly dependent upon supersaturation and independent of crystal size (i.e., McCabe's delta  $L$  law holds), while nucleation is linearly dependent upon both supersaturation and crystal surface area. Values of a rate coefficient for the inbuilding process are also presented.

Messrs. R. P. Ayerst and M. I. Phillips of the Ministry of Technology, Explosives Research and Development Establishment at Waltham Abbey, Essex, presented two papers on ammonium perchlorate crystallization. The first reported the effects of varying cooling rates upon crystal size distribution in batch-cooling tests. The second reported effects of varying throughput rates upon CSD obtained from a continuously operated Kestner forced circulation evaporative crystallizer of 5 to 10 kg./hr. capacity. Their product size distributions closely approached those predicted for a completely mixed crystallizer.

Other papers presented research studies on crystallization of ice from glucose solutions, a theoretical treatment of Ostwald ripening, the dependence of sucrose growth on seed quality, the growth of ammonium alum in fluidized beds, precipitation conditions on the settling rate of ferric hydroxide from steel pickling liquors, and crystallization of wax from oils by cooling.

This collection of papers, generally of high quality and interest to a broad spectrum of readers, represents a significant contribution to the literature. It is hoped that the Institute of Chemical Engineers will be encouraged to hold a similar symposium in the near future.

THOMAS F. CANNING  
KERR-MCGEE CHEMICAL CORP.  
TRONA, CALIFORNIA

**Chemistry of Complex Equilibria**, M. T. Beck; trans. ed., R. A. Chalmers, Van Nostrand Reinhold Co., Ltd., London (1970). 285 pages. \$12.00.

This book, published first in Hungary, should prove very interesting to the chemical engineer who is looking for a

general discussion of the field of coordination chemistry in solution. It is well written and provides a recent and comprehensive review of the subject (over 900 references, extending through 1968), and only a good background in classical physical chemistry plus some inorganic chemistry is required.

The author neither draws on nor discusses to any extent either quantum or statistical mechanics. The mathematical analyses, although a bit cumbersome in places, are not abstruse and are followed probably more easily by an engineer than a chemist. As a matter of fact, although the use of computers is mentioned only briefly in Chapter 4, it would seem that many of the calculational procedures mentioned would readily lend themselves to computer solutions.

In the Introduction, Chapter 1, the author defines what he means by complex equilibria between metal ions and ligands. He gives some historical review of the development of the field and stresses the impact that he feels the work of Dr. Jannik Bjerrum had on this area.

The next two chapters describe complex equilibria in terms of the equilibrium constants for the addition of each successive ligand to a metal cation. There is a discussion of the use of activities instead of concentrations in the equilibrium expression, but it appears that the thermodynamic techniques and data available are not adequate for this refinement. The complex formation function is defined for the series of equilibria.

The fourth chapter explains a number of numerical and graphical techniques for evaluating the equilibrium constants in the series. There is a very brief and general mention of the use of electronic computers for such calculations, but no techniques or programs are given. The computer is an obvious tool for solution of problems of this type; certainly these machines and the techniques for using them must be much more readily available in this country than in Hungary. It appears that it would be fairly straightforward to develop good programs for these computations.

Chapter 5, which makes up perhaps one quarter of the text and contains nearly forty percent of the literature

citations, is an excellent discourse of experimental methods. A very large number of techniques are discussed, including spectroscopic, electrical, thermodynamic, and kinetic. The discussion of their applicability is quite good, but the emphasis is on the more classical approaches. Again, the U.S. reader should bear in mind that some of the methods are designed so as to simplify the calculational procedure, which will be less important if a computer is available. The following five chapters treat a number of special cases, including the protonation of complexes, aquocomplexes, mixed ligand complexes, complexes of the outer-sphere type, and polynuclear complexes.

Chapter 11, of a more general nature, deals with the effect of various factors on the stability of the complexes. The author discusses at some length the effect on stability constants of both the electrical properties as well as the chemical nature of the species, both for the central ion and for the ligands. However, only the briefest mention is made of the effect of thermodynamic variables, such as temperature, pressure, and solvent medium. This is unfortunate, as it would appear to this reviewer that these might prove powerful tools for the study of complexes. For example, the effect of pressure on an equilibrium constant would yield directly the volume of formation of the complex, and the variation of this volume from solvent to solvent could give information about the electronic distribution in the complex from the variation in electrostriction. In the final chapter, the author postulates the directions he believes future work in this area will take.

All in all, this book covers well the classical theory for complex equilibria. It contains numerous applications and gives a good view of the experimental methods used plus the techniques for interpreting results. It should be readily understandable by most chemical engineers and provides a good value as a reference for those interested in the area.

CHARLES A. ECKERT  
UNIVERSITY OF ILLINOIS  
URBANA, ILLINOIS

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