

try, including a treatment of excited states, and finishing with a Conclusion and Assessment.

One would have liked to see some more mathematics (in an appendix so as not to spoil the simplicity of the book). Thus it seems likely that a proof better than the one on page 19 is possible, so that the last paragraph on page 21 would not have to be apologetic. Then too, some of the superiority of Professor Linnett's approach in the case of the allylic examples may be vitiated when it is realized that the advantageous electronic distributions found are also provided by valence bond structures as ψ^2 's (not as ψ 's). One is not sure that the author consistently uses ψ^2 's for probability densities. Again, not enough attention is given to promotion (yet even if $2s^2$ is left out and bonding in O_2 is described using pure $2p$, one seems to retain the advantage of the Linnett method).

The author states that the book "is not, and was never intended to be, the final word." His aims are to make the hypothesis clear and to provide examples, some more definitive, some to indicate where future progress might be made. These aims have been accomplished. The book is certainly to be recommended, and to "old hands" as well as to beginners.

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Azeotropic and Extractive Distillation. By E. J. HOFFMAN. John Wiley and Sons, Inc., 605 Third Ave., New York, N. Y. 1964. xi + 324 pp. 15.5 × 23.5 cm. \$14.00.

This book represents Volume 4 of a new series by Interscience Publishers directed toward "Chemical Engineering and Processing." The prior volumes have dealt, respectively, with new separation techniques, mass transfer calculation methods, and liquid-liquid equilibrium. These, as well as the present volume, are in keeping with a recent trend of publishing books dealing with highly specialized topics in chemical engineering. This reflects the increasing specialization of chemical engineers in industry and in universities, as well as the difficulty in producing books of wide scope which are up to date during a period when engineering is undergoing a technological metamorphosis.

Thus, these books are not generally appropriate as undergraduate texts, as training at that level must be based on broad fundamentals rather than on specialized topics. However, several such books can form the basis of a graduate course in allied topics. In such a course their use is often as a reference, while current literature provides the substance of the course material. The practicing engineer might build up a small library of such books as reference sources for advanced techniques in particular specialties. Therefore, this review will be based on an analysis of the book's utility as a reference work for azeotropic and extractive distillation.

The first two chapters are concerned with defining nomenclature, the controlling equations of heat and material balance, and the degrees of freedom available consistent with the number of variables in a particular design situation. Material is presented in a useful and generalized manner and there is extensive graphic illustration of the principles involved. In fact, throughout the book one is struck with the extensive use of graphical presentation and calculation techniques.

Chapter 3 is summary of the necessary thermodynamic relationships to design for a multiphase, multicomponent system. Again the chapter is profusely sprinkled with phase and temperature-composition diagrams to illustrate various types of behavior. The requisite thermodynamic relations are derived from first principles.

The next three chapters consist almost entirely of graphical presentations of typical and atypical binary and ternary distillation systems. The author evidently thinks that by acquainting the reader with a wide variety of systems he can inculcate a qualitative reasoning ability as to alternate processing schemes in various situations. It would be a great assistance if this presentation had been more completely supplemented with textual material and illustrative examples. The reader is somewhat confused by the tremendous array of various types of ternary diagrams.

Chapter 7 is a short chapter in which the use of ternary diagrams for the solution of extractive distillation designs are presented. Discussions in previous chapters have been largely oriented toward azeotropic distillation cases.

The next three chapters represent the most useful ones in the book. Here specific design cases are discussed for multicom-

ponent systems. The illustrative examples given are very helpful. Various techniques are discussed in which alternate assumptions such as constant molar overflow, constant relative volatility, etc., are used to solve the multicomponent design case. These chapters represent a useful reference source for such calculation techniques, largely numerical in nature and do not utilize the graphical methods and presentations of earlier chapters.

Chapter 11 is a summary of literature sources which deal with plate and column efficiencies and the effect of design parameters on these efficiencies. An attempt has been made by the author to be selective in his review of the literature. This material is more effectively presented in other sources, and its inclusion here is justified only in making the treatment complete within this volume.

There is a problem set for respective chapters included at the end of the book. At the end of each chapter appropriate references are given so that the reader may go to more complete treatments of highly specific topics.

One might very well question as to whether a reference work, or text, is required in this specialized field. In principle, an extractive or azeotropic column is just like any other distillation column once the separating agent has been added to effect the desired change in relative volatility between components to be separated. Once this new distribution of relative volatilities is known, conventional calculation procedures are appropriate. These methods have been presented in other places. Further, one might question the necessity of having available extensive representations of a variety of distillation paths for ternary systems. It is true that study of such a folio gives one a better "feel" for column performance that might be expected with various irregular systems. However, is purchase of a book necessary to acquire this qualitative understanding? It is doubtful.

From an over-all viewpoint, the book is a curious collection of topics which, taken together, do not project a clear-cut or complete compilation of existing knowledge in azeotropic and extractive distillation. The omission of the following topics, so important in this area, is to be deplored: (1) discussion of the activity coefficient approach to correlation and prediction of multicomponent, nonideal mixtures; (2) comprehensive presentation of factors affecting choice of extractive and azeotropic agents for particular situations; (3) omission of much of the important current literature in the field, especially that describing important processes in which extractive and azeotropic distillation are involved; (4) lack of a completely worked-out example where a column is designed from first principles, and calculations are continued to the final stage, including enthalpy balances; (5) lack of discussion of importance of computers to this type of design.

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On Physical Adsorption. By SYDNEY ROSS, Professor of Colloid Science, Rensselaer Polytechnic Institute, and JAMES P. OLIVIER, Freeport Kaolin Company. Interscience Publishers, John Wiley and Sons, Inc., 605 Third Ave., New York, N. Y. 10016. 1964. xxv + 401 pp. 16 × 23.5 cm. \$15.00.

Although the title does not say so, this book is restricted to adsorption of *gases* on solids, mostly possessing nearly homogeneous surfaces, and furthermore taking place in the region below the monolayer. Ross and Olivier have really produced an expanded research treatise summarizing the work of many years at Rensselaer by Ross and his collaborators to develop workable mathematical techniques to express the interaction of adsorbed molecules with solid surfaces.

The main effort is directed at the development of a unified theory for mobile adsorption on a heterogeneous surface. The expression for the isotherm is based on the Hill-de Boer two-dimensional van der Waals equation. Real surfaces are considered to be composed of small patches (50 is taken as a realistic and manageable number) which have specific and constant interaction energies over each one and independent of the others. Since 1954, Ross has promoted the term "homotattic" for such patches, but with only limited acceptance. For convenience, these adsorption potentials are given a gaussian distribution. To make analysis of data tractable, the last 100 pages are devoted to tables of the fraction of surface covered as a function of the pressure and the two-dimensional van der Waals constants.

The intent of the authors, as they say in the preface, is to provide a practical guide for the experimenter. With this in mind and particularly for new workers in the field, the second chapter is devoted to experimental techniques. There is some unevenness here and the authors do not always critically assess the descriptions taken from the literature.

The introductory Chapter I is devoted to the application of the phase rule to surface phenomena, to the classification of adsorbed films as mobile or localized, and to the characterization of the contributions to adsorption potentials. The various types of heats of adsorption potentials are discussed in Chapter III. Surface heterogeneities are characterized and isotherm models for them are presented in Chapters IV and V. In Chapter VI, the evaluation of the parameters for the theory is presented. Applications are made in Chapter VII. It becomes apparent that when the refinement of considering the polarization of the adsorbed molecules by the surface is finally included, then the fit of the theory to the measured isotherm is best at low pressures. But there is considerably increased departure at high pressures.

As J. H. de Boer states in a Foreword, the authors are to be congratulated for attempting to relate real surfaces to a workable model for the physical adsorption of gases on them. Yet it seems doubtful that workers will rush to employ the Ross-Olivier approach. We need to know more about heterogeneities and about the positions of adsorbed atoms with regard to each other and the surface before the goal will be realized.

There is such a proliferation of adsorption theories at the present time as to baffle the researcher (but then there are even more variations in surfaces). This reviewer had hoped that a comparison of theories and approaches would be discussed in this book. Such a critical survey would serve a useful purpose.

It must be said that Ross and Olivier have produced a scholarly review of their procedures and of the thermodynamics surrounding them. Very few errors have crept into the text, either committed by the authors or printer. That the term "heterogeneity" should be applied to the *system* not to the surface, might be further emphasized wherever used; thus chrysotile is rather homogeneous toward water vapor, but heterogeneous toward argon. No author index is included. Any serious worker in the field, it must nevertheless be concluded, will find this book to be a valuable contribution.

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