ChE book reviews

AN INTRODUCTION TO CHEMICAL ENGINEERING KINETICS IN A REACTOR DESIGN

By Charles G. Hill, Jr.
John Wiley and Sons, 1977
Reviewed by Kenneth J. Himmelstein
University of Kansas

This text is intended to be an introductory text to Chemical Reactor Kinetics and Reactor Design. It covers in detail the thermodynamic and kinetic considerations that enter into the reactor design process.

The major subjects which need to be included in such a text are done well, including the use of concepts in reactor and chemical kinetics, basic development of reactor design, as well as covering such topics as non-ideal flow, thermodynamic considerations, and optimization techniques.

The book combines some of the best features of its most recent predecessors in reaction engineering textbooks. The development of the key concepts of the book are considered in greater detail and based on a more "first principles" approach than previous texts. Yet, it avoids the very abstract A → B approach by combining the detailed derivations and presentations with concrete examples which are based on data from real situations. This combined approach allows the author to present more deeply those concepts which the student should take from any introductory course to be applied in future years, while at the same time allowing the student to feel that he is studying real chemical engineering as opposed to some abstract classroom exercise. The attention to detail in this book is outstanding and gives the student a significant feel for problems associated with design of chemical reactors. This text is richly illustrated and documented, well referenced, and provides appropriate thermochemical data.

The major problem with the book is its organization. The first seven chapters (forty percent of the book) are devoted to chemical kinetics, while the last eight chapters are largely devoted to design of chemical reactors. Thus, there is marked division between analysis and synthesis. The student is not introduced to the concept of a reactor except very briefly until the book has used approximately 250 pages. This is undesirable in that the art of synthesis is best appreciated when the science the student learns is immediately applied practically. For instance, some of the basic concepts of heterogenous catalysis covered in the section on chemical kinetics are not used until much later. The student looses the chance to employ the details presented by the authors and must go back and review or relearn the material. There is an additional problem of organization in that the determination of reaction rate expressions is covered in the third chapter while the basic concepts of chemical kinetics (the molecular interpretations of kinetic phenomena) is not covered until the fourth. Thus, the student is left to guess at rate expression forms without any knowledge of why those forms are appropriate.

Finally, as a concluding chapter to the book, the author includes two illustrated problems of extended length and detail in reactor design. These extended problems are extremely valuable and offer significant improvement over the previous texts, in that it certainly considers the widely varying considerations that one must include in a complete reactor design.

In conclusion this book is a well detailed, somewhat deeply developed, treatment of chemical kinetics and reactor design to be used as an introductory text. It does its job well except for organizational problems. It is excellent an basis for a one or two semester course in chemical reactor engineering. □

INTRODUCTION TO OPTIMIZATION THEORY

By B. S. Gottfried and J. Weisman
Prentice-Hall, 1973
Reviewed by Thomas F. Edgar
University of Texas at Austin

This book is written as a formal exposition of optimization theory. As such, it does not appear to be suitable for the first exposure to the subject of optimization, either for an undergraduate student or a practicing engineer. Although this text probably could be used in a graduate course in optimization, the subject matter is more heavily slanted towards the operations researcher than towards the chemical engineer.

Introduction to Optimization Theory does not present a point of view which differs significantly from that available in existing tests. There are very few new insights or approaches used in the authors' development of optimization theory or algorithms. Therefore the selection of this textbook over others will rest upon how well it matches the specific topics to be covered and the depth of coverage of a given course.

The chapters cover necessary and sufficient

conditions for an optimum, one-dimensional optimization, unconstrained optimization, linear programming, nonlinear (constrained) optimization, staged system optimization, and optimization under uncertainty and risk. The last topic is the only unconventional chapter in the book. The chapter on linear programming takes a reasonably fresh, although rigorous, viewpoint. The LP presentation is not based on a cookbook manipulation but on vector-matrix manipulations. It is precisely this pedagogy, however, which makes the book non-introductory in nature.

The book will not help bridge the gap between theory and practice; very few complicated or real-world examples are worked out and presented. Another deficiency is that very few numerical details are provided, which would help the reader understand the computer "behavior" of various algorithms. Very few direct comparisons of comparable algorithms via common problems are drawn. At the end of several chapters, the authors give their recommendations on which methods to use for different types of problems, but their comments tend to be superficial and to ignore the many studies on optimization algorithms that have been undertaken. For example, the authors state that it is not possible to generalize upon the performance of existing nonlinear programming algorithms, a point with which I disagree. The authors devote only one paragraph to Powell's non-derivative method; it certainly deserves more. They also fail to point out some obvious deficiencies of some algorithms; e.g., the fact that the Davidson-Fletcher-Powell method becomes disadvantageous for large problems.

This book, like several others published recently, also includes a chapter on optimization of functionals. I have mixed feelings about including such a topic, since a single course on optimization must by necessity devote 95% or more of the lectures to static optimization. Therefore, such a topic is of dubious value in a book like this, except for limited self-study. In order to gain the proper perspective and background for optimization of functionals, the interested student or professional should take a course or read a book devoted exclusively to optimal control.

In summary, *Introduction to Optimization Theory* is a noble effort to use a rigorous, interdisciplinary approach for developing various optimization techniques. Its notation is clear, but to most chemical engineers the material and examples presented will seem a little sterile. □

RECYCLE REACTOR

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APPLICATIONS

EQUILIBRATION TIMES WERE determined by continuously monitoring the effluent composition with an infrared CO_2 analyzer. Steady state was generally realized in 30-60 minutes. Consequently, a large amount of data can be obtained in a relatively short time, making this system ideal for both undergraduate catalyst characterization experiments and graduate level research. Furthermore, catalyst beds can be easily changed, allowing the ready investigation of many different types of catalyst.

CONCLUSIONS

No laboratory reactor is truly ideal; nevertheless, the recycle reactor appears to offer a practical and educational solution to many of the problems which plague heterogeneous catalytic investigations, insofar as it offers isothermal operation at easily measured conversion levels. □

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