Chemical Reactor Design, Optimization, and Scaleup

By E. Bruce Nauman, Wiley, Hoboken, NJ. 2008, 608 pp., $135.00

This book, while formally a second edition, represents the third edition in the series initiated by the late Professor Nauman's *Chemical Reactor Design*, published in 1987. The topics covered include reaction engineering fundamentals (rate laws, elementary reactions, systems of multiple reactions, ideal reactors, reactor networks, energy balances in nonisothermal reactors, and fitting rate data); other topics traditionally found in reaction engineering texts (tubular reactors, heterogeneous catalysis, multiphase reactors, unsteady-state systems, and residence-time distribution); and several topics not always covered in reaction engineering texts (biochemical, polymer, and microscale reaction engineering). The intended audience includes students in both undergraduate and graduate courses as well as practitioners seeking practical guidance. Throughout, the book routinely emphasizes the use of numerical solutions rather than simplifying problems in order to enable an analytical solution.

The preface identifies practitioners as an intended audience even before mentioning the academic community. The text includes several elements that should appeal to the community of industrial reaction engineers. These elements are among this work's greatest strengths and make this book worthy of addition to the library of any practicing reaction engineer. For example, issues relevant to the scale-up of a chemical reactor are tackled beginning in the very first chapter, which introduces the concepts of characteristic reaction time, mixing time, and residence time. By the end of the fourth chapter, the reader has been fully exposed to the concept of scaling factors. Realistic examples and useful advice for the scale-up process are given for a host of cases, including tubular reactors and stirred-tank reactors. The early and consistent connection between abstract concepts and the challenge of successful scale-up is a true strength of this text.

A second strength of this text is its unwillingness to ignore the complexities introduced by features of the system thermodynamics and transport phenomena that make reactor design, scale-up, and optimization problems mathematically more difficult. For example, variable density liquid phase systems are described early in the text, not ignored because they lead to problems with no analytical solution. In the chapter on multiphase reactors, the reader is not left with mass-transfer coefficients as abstract concepts; rather, the text cautions the reader to be careful when applying literature correlations and then describes techniques for the measurement of mass-transfer coefficients.

In my opinion, the strengths of this text far outweigh its weaknesses for its intended audiences. The industrial reaction engineer will find more practical guidance than in the typical reactor design book, and the academician will find a work that enables the instructor to illustrate various concepts with real-world examples. As admitted in the preface, some of the nomenclature is eccentric, but the notation table appears to be complete, enabling the committed reader to understand the equations given sufficient motivation to keep a finger in the nomenclature section. While the examples of Basic code sprinkled throughout this book are probably not an important aid to a student or practitioner with access to commercially available mathematical modeling software, these elements are more of a distraction than a liability.

In summary, I heartily recommend *Chemical Reactor Design, Optimization, and Scaleup* to the industrial reaction engineer looking for a reference that effectively addresses the fundamental issues in reactor scale-up. I also recommend this text to the undergraduate level chemical reaction engineering course instructor who seeks a text that properly addresses the knowledge and skills required to solve reaction engineering problems commonly encountered in the workplace. This textbook serves as an excellent legacy of a leader in the field of chemical reactor design.

Daniel A. Hickman
Engineering Sciences
The Dow Chemical Co
1776 Building, Midland,
MI 48674
E-mail: dahickman@dow.com

AiChE Journal, Vol. 57, 3243 (2011)
© 2011 American Institute of Chemical Engineers
DOI 10.1002/aic.12602
Published online March 31, 2011 in Wiley Online Library (wileyonlinelibrary.com).

Principles and Modern Applications of Mass Transfer Operations

By J. Benitez, John Wiley and Sons, Hoboken, NJ. 2nd ed. 2009, 620 pp., $115

I found the style of the book and the methodology very refreshing and practical. It shows much care for the students in that it is humble, straightforward, clear and practical, with much emphasis on teaching and a bit less on demonstrating knowledge. It is a model of what modern undergraduate teaching books can be and Dr. Benitez should be commended for his focus on teaching and developing students. Not easy to take on the stoic figures of Treybal, King, and other luminaries of mass transfer texts, and come up with a different and useful piece of work. One example of this focus is the extensive use of "objectives statement" in the chapters. I find it fascinating how when you tell someone what you are going to teach them, you already accomplished 80% of the teaching. This is a very good and healthy practice in books or in other engagements with students and professionals.

I have to say although, the book does leave something to be desired in the "modern applications" aspect. It misses the opportunity of addressing mass transfer operations and examples in some of the most modern equipment (i.e., structured packings, enhanced gravity trays, microchannels, etc.), and sadly relates examples and data to mass transfer equipment that is basically old technology. Furthermore, the models mentioned and reviewed in the book for mass transfer in towers are not at the top of the list in terms of quality and rigor.

Part of this problem I believe comes from the book also lacking a serious discussion of the heat/mass/momentum transfer analogy and of interfacial phenomena that have direct effects on mass transfer operations. Such discussion leads one to the concept of generalized models that are mechanistic, and as such, give students a deeper understanding of the processes and properties that govern mass transfer. Some other omissions include the lack of discussion of vapor/liquid/liquid/solid equilibria, and how thermodynamics plays a fundamental role in mass transfer variables such as stage efficiency. I would have liked to also see a discussion of reactive separations where mass transfer and chemical reaction are combined, and a thorough treatment of the degrees of freedom when specifying or describing a mass transfer problem.

Clearly, Dr. Benitez has made a wonderful contribution to the tools of chemical engineering. I am sure that the third edition will be a book to behold, with many more illustrations and a wider coverage, but keeping his unique and laudable focus on the learning's for the students.

Jose L. Bravo
3333 Hwy 6 S
Houston, TX 77082
E-mail: J.Bravo@shell.com

AiChE Journal, Vol. 57, 3243 (2011)
© 2011 American Institute of Chemical Engineers
DOI 10.1002/aic.12641
Published online April 28, 2011 in Wiley Online Library (wileyonlinelibrary.com).