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Book reviews

Biological Process Engineering. An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems. Arthur T. Johnson, John Wiley and Sons, 1999, 732 pp., £58.50, hardback, ISBN O-471-24547-X

This is a book about transport phenomena and how they relate to biological processes. The breadth of the book is remarkable. Arthur Johnson has peppered his book with examples from sciences as diverse as biomedical, plant, soil, ecological, and food sciences. But equally striking is the way he has taken the analogy between fluid flow, heat transfer, and mass transfer one or two steps further. They are related in detail to electrical and mechanical phenomena, with an occasional aside on how the analogies can be further extended to optical, magnetic, and other phenomena. If a major branch of biological or physical sciences was left out, I did not notice. Such a book will especially appeal to the nimble mind.

The intended audience is primarily students in the emerging field of biological engineering. There is a particular need for texts in this area in the United States, where the traditional role of the agricultural engineering department is being broadened in its biological content. Use of examples such as the estimation of a convection coefficient for people in hot tubs and mass transfer through human skin lends a fresh, and often wry perspective to the subject matter. The food process examples tend towards the more conventional types found in other books, but help demonstrate the many facets of biological transport processes.

For myself, the most valuable contribution of Arthur Johnson's text is the use of many examples of transport processes applied to human physiology. This is shown nicely in his progression from resistance to flow in rigid pipes, where the realm of the chemical process engineer usually stops, to resistance to flow in elastic tubes. The latter case typifies the multitude of plumbing inside living organisms. Another is his description of the intestines and other organs as 'mass exchangers' analogous to the heat exchangers that process engineers know so well. The biomedical aspect of the text appears to be Johnson's forte. If the book had focused even more on that area, it would not have been diminished.

This leads to my main quibble about the book, regarding its pedagogical use. The book appears to be intended for use in a first course on transport processes; however, I fear the sprawling scope of the book would overwhelm many such students. An effective teaching book should build the students' confidence in their ability to solve problems independently. The author's unified presentation of transport processes is a plus in this regard. But a successful problem-solving technique requires an understanding of what simplifications can be made in order to obtain both a manageable equation and a useful result. A unified approach to doing this is beyond the reach of even this book. The diversity of examples, each often requiring some biological or other knowledge to competently simplify the equations, may ultimately undermine the students' confidence. Also, in his preface, Johnson suggests a desire to connect with those 'right-brain-dominant' students, that is students who are more creative but less mathematically oriented. This, I agree, is a valid concern; traditional engineering texts have ignored such individuals. But the right-brain-dominant students will struggle to get past chapter one of this book.

Nevertheless, teachers of biological transport processes should become acquainted with this book, and students should have access to this book as a reference. Johnson's examples and his frank remarks following each example make for interesting, accessible reading. The explication of the analogies between the various transport processes could be particularly effective for advanced students of transport processes. I will be recommending this book for use as an important reference in our educational program.

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Chemical Engineering Design and Analysis. An Introduction. T. Michael Duncan and Jeffrey A. Reiner, Cambridge University Press, 1998, 380 pp., hardback, US$90.00, £65.00, ISBN 0-521-63041, softback, US$39.95, £22.95, 0-521-63056-5

Chemical engineering is a fascinating but difficult profession. This book by Duncan and Reiner takes on a noble and useful task: persuade students with various backgrounds to

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join the profession by emphasising its highly creative nature through design and analysis. According to the authors, the book has two goals: firstly, to describe chemical engineering as a profession, and secondly, to introduce and develop basic engineering skills.

To avoid misunderstanding it is necessary to be precise about the semantic meaning of the title. By design the authors mean 'the ability to conceive and to develop plans', while analysis is 'the methodology to model and evaluate chemical and physical processes'. The word 'introduction' in the title should be kept in mind. In this respect the prerequisite knowledge of chemistry, physics and mathematics for following the book is only elementary. As a consequence, it should not be seen as a process design teaching course in a professional sense.

The book is divided into six chapters: overview, process design, models, graphical analysis, dimensional analysis, and transient processes. The chapter devoted to process design introduces some basic elements of a chemical process and emphasises its creative features. The authors use five well-selected examples: ammonia synthesis, purifying heptane, production of electronic-grade silicon, generation of electric power by means of fuel cells, and the desulphurisation of natural gas. Their clever choice does more than illustrate the diversity of chemical engineering. In fact, they provide opportunities to introduce key concepts such as; flowsheets, unit operations, recycles, physical properties, and economic trade-offs. Asking questions enables the authors to reveal the fundamental disciplines forming the hard core of chemical engineering.

Three chapters present analysis tools which an engineer can use to solve a design problem: models derived from laws and mathematical analysis, graphical analysis, dimensional analysis and dynamic scaling. Here more quantitative features, such as material balances, analysis of data, formulation of a model, and scaling of phenomena, are introduced. However, most of the material is based on qualitative reasoning rather than on abstraction through natural laws. Although this approach may be justified for educational reasons, in the longer term it runs the risk of generating a phobia against a more quantitative and sounder approach. Even more critical is the diluted treatment of the thermodynamic principles, which are essential for understanding a design process. The appendix on 'mathematics, mechanics and thermodynamics' has only three pages.

The final chapter handles transient processes as a general framework for introducing design principles based on the kinetics of phenomena, mainly in the field of reaction engineering. It is also an opportunity for a more rigorous approach, by including the time co-ordinate and differential equations.

The educational approach in this book is by examples and definitely not by theory. Each section contains a large number of problems, from different areas, of various difficulty, some of pure logic, some open ended. These offer a huge amount of material for customising the course to the level and interest of each class. Unfortunately, some (real) problems cannot be solved because the available knowledge is insufficient. For example, asking about the sizing of units and optimisation is premature, or should be restricted only to the level of 'good questions'. In this respect the role of the teacher is essential, in order to deliver the 'right answers'. A problem solution manual, possibly open to discussions on the Internet, would be a great help.

Summing up, this book is highly original and refreshing, both for its content and its presentation. The style is informal and stimulates curiosity. It offers an initiation into chemical engineering, by revealing its high innovative value and the contemporary challenges of the profession. This book can be used with real benefit as an introductory course in generalist universities, where insufficient scientific skills are often seen as the main hindrance in attracting students to the chemical engineering departments. Finally, this approach can be seen as 'something different', complementary, but not in direct competition with more advanced textbooks.

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The Colloidal Domain: Where Physics, Chemistry, Biology and Technology Meet, 2nd Edition. D. Fennell Evans and H. Wennerstrom, Wiley-VCH, 1999, 632pp., hardback, £58.00, ISBN 0-471-24247-0

As the authors of this book say, great strides were made in the decades leading up to the 1930s in laying what have since become the foundations of colloid science. They point out however that for some considerable time following this, colloid science was 'relegated to the intellectual backwaters of science.. ' Indeed E.S. Hedges wrote, in 1931, about a common contemporary view of colloid science in the following terms. 'To some the word 'colloidal' conjures up visions of things indefinite in shape, indefinite in chemical composition and physical properties, fickle in chemical deportment, things infilterable and generally unmanageable'. What this excellent book does is to show us that colloid science has become a very modern science, with relevance in a range of other pure scientific and engineering disciplines, and with application in numerous industrial processes. It is now grounded in secure theory, served by a battery of modern instrumental methods and ready to take on a whole range of new challenges.

The general appearance and feel of the 2nd edition are much like that of the first. The book is very reader friendly with copious figures and illustrations. There is a large margin down the left hand side of the page into which