distillation, cryogenic crystallization and multi-azeotropic distillation. The inclusion of byproduct production makes this furfural book unique and also sheds useful light on improvement of furfural processes by enhanced by-products.

Many furfural derivatives, which include furan resins, THF, THFA, furan, furoic acid, methyl furan, maleic acid, difurfural, pyrazines, hydroxyfuranone, furan dialdehyde, and xylose, are reviewed briefly without providing production technologies. However, furfural alcohol and polytetrahydrofuran (PTHF) are more focused. The production of furfural alcohol is described in both vapor phase and liquid phase processes. The synthesis of PTHF from THF is illustrated in laboratory experiments using three commercial catalysts, but little information on industrial processes is provided.

While reading through the book, I was impressed by the spotlighting of specific details, such as the inline measurement of furfural, the discoloration of furfural, the acid strength change with temperature, and several corrosion control examples. This can only come from insightful thought and long term experience in the furfural industry. Compared to the reviews on furfural in several encyclopaedias, Dunlop and Peters' 'The Furans', and several furfural books in Chinese and Russian, this book presents clear reaction mechanism and kinetics. The format is very readable. For the readers interested in engineering and economic analyses, they should look for additional sources. In summary, this monograph is a very good technical book for the furfural industry. Anyone concerned with how furfural processes function or are interested in the field can learn much from it.

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PII: S1385-8947(00)00182-0

Coulson and Richardson's Chemical Engineering, Volume 6, Design, 3rd edition

R.K. Sinnott, Butterworth-Heinemann, 1999, 1045+xxv pp, £29.99 (paperback), ISBN 0-7506-4142-8

Let us be clear from the outset: this is an especially useful book for every student of chemical engineering and it meets its aim of having relevance to most present-day undergraduate design projects. The specialist will find omissions and maybe even a bias towards the thinking of the era of the book's first publication in 1983 (the cover picture of old-fashioned computer displays reinforces this view). However, this remains one of the most easily digested and comprehensive collections of practical information on chemical process design available. Undoubtedly, Perry's Handbook contains much more detail and theory, but you could not contemplate reading more than a very small section at a time. Other books deal more thoroughly with particular aspects, such as control or distillation. The danger with a book of this kind is that, with successive editions, gaps are filled and topics are treated with increasing depth until eventually the author's original intention is overwhelmed by the sheer size of the volume. At over 1000 pages, 'Volume 6' (as it is commonly referred to by students) is nearing this stage.

Ten of the book's 14 chapters deal with process design, starting with consideration of the design method per se and covering balance calculations, flowsheeting, control, costing, materials selection, safety and the environment. Of the remaining chapters, three deal with equipment design with particular emphasis on heat transfer and separation columns, and the other deals with mechanical design. There are 10 appendices providing a wealth of practical data including physical properties and corrosion charts, along with drawing symbols, specification sheets and example projects. The book is well written and clearly presented.

The book has a strong emphasis on continuous chemical and petrochemical processing. This accords well with the traditional undergraduate design project. However, the traditional project is increasingly being called into question as reflecting less and less the kind of design work most commonly carried out by today's graduate chemical engineers. Batch processes only get rare mentions in the book, revamps not at all, unsteady-state balances get a brief treatment but readers are referred elsewhere for details. One of the problems facing many educators in the UK is how to break away from design work on classical continuous processing. A chapter dealing with modern processes, especially for complex materials, foods and high value batch products, would have been a welcome and timely addition to the new edition.

Most chapters end with extensive lists of reference material. This is particularly useful in expanding on topics too complex for full treatment in the text but the bias is to works from the 1960s and 1970s, with very few post 1990. There may be a case for including some original references but is Dantzig's 1963 paper on the Simplex method seriously a better source than a modern text on linear algebra (which would include additionally the more recent developments in that subject)? For references to be useful, students must also have a realistic chance of finding them, yet most of the books published before the 1990s are out of print and may not even be in the libraries. Furthermore, older publications have often been reworked, augmented and presented more accessibly in recent books. In other cases, the references are just plain out of date: this is particularly so for the computer-related topics and it is disappointing still to find no reference to the IChemE's guidelines on computers, now in its 3rd edition. [1]

Returning to the positive, the book has excellent chapters on the practicalities of developing a process design. In the space of a short review, it not possible to do it full justice, so

[1] IChemE CAPE Subject Group, *Good Practice Guidelines on the Use of Computers in Chemical Engineering*, 1999, available free from http://CAPE. icheme. org/.

examples will have to suffice. Mundane topics like material and energy balancing are treated in an easily comprehensible manner and include a nitric acid flowsheet as an extended example. The chapter on piping, instrumentation and control is refreshingly devoid of Laplace transforms and matrices, yet gives practical recipes for common equipment control problems. Similarly, costing and materials selection is given a practical gloss. Special mention must go to the chapter on design information and data: it is educationally important that students encounter unusual materials and this chapter provides a useful starting point for estimating the unknown physical properties.

It is easy to understand the popularity of this book amongst generations of students, for it provides under one cover everything they appear to need to know for their final projects. The tutor's task is to show that, while it is indeed incredibly useful, it is only the beginning and far from the end of the story.

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PII: S1385-8947(00)00184-4

Thermodynamic optimization of finite time processes
R.S. Berry, V.A. Kazakov, S. Sieniutycz, Z. Szwast and A.M. Tsirlin, John Wiley and Sons Ltd., 1999, 471 pp., £ 120.00 (hardback), ISBN: 0-471-967521

The book is an impressive monograph treating many of the results in finite-time thermodynamics for the last 25 years. Although the emphasis is perhaps a little heavy on the results of the Russian school, the number of examples treated and the unity achieved is certainly a welcome addition to the literature in the field. The authors begin the book with their stated goal: "to show how the methods of optimal control theory can be used to estimate the limiting possibilities of thermodynamic systems." They carry out this goal to a remarkable extent.

The book begins with a brief review of the basic thermodynamics of closed and open systems. The closing section of Chapter 2 does a particularly elegant job of laying out a framework for the formulation and solution of finite-time thermodynamics problems including the much-needed disclaimers of exactly what the subject can and cannot do.

The book continues in Chapter 3 with a well written treatment of optimisation theory which starts where a normal calculus sequence leaves off, and takes the reader through a thorough treatment of finite-dimensional non-linear programming. Chapter 4 continues their exposition of optimisation theory with a good introduction to optimal control. In this chapter, the style changes somewhat interspersing the exposition with numerous examples of finite-time thermodynamics problems that illustrate the theory as it is developed. Their treatment of optimal control theory is novel, in that it includes an excellent development of the so-called 'average theorems' due to Rozonoer and Tsirlin. These theorems are of vital importance to many results in finite-time thermodynamics but are not part of the normal treatment in any other optimal control theory book. These theorems, along with the assumption of endoreversibility, reduce many finite-time thermodynamics problems to non-linear programming problems in finite dimensions. One important achievement of the book is to make these results accessible to a wide audience without requiring excessive prior knowledge of optimisation theory.

The remaining chapters present a systematic review of the problems in finite-time thermodynamics. The organisation proceeds from simpler systems, in which there are a limited number of heat exchangers and reservoirs, to more complex systems that interact with a number of reservoirs and incorporate mass transfer and chemical reactions. The number of problems presented is impressive and certainly represents a significant synthesis well beyond the reviews of the subject that were available before this monograph.

The book is not without some minor flaws, however. One weakness concerns the authors' use of the English language. English is not the mother tongue of four of the five authors and the book would have benefited from more corrections of an editorial nature. The abuse of the definite and indefinite articles in many of the sections makes for some difficult reading. There are also some unfortunate choices of nomenclature. For example, the use of NP for the non-linear programming problem clashes with the usage in combinatorial optimisation for NP hard problems. Phrases, such as 'poweral efficiency' for an efficiency based on power, are less than judicious.

A second flaw is the limitation in scope resulting from the complete omission of certain topics. Notable among these are (1) results dealing with the geometry of thermodynamic length and the associated bounds they give on the dissipation in finite-time processes, (2) results dealing with the thermodynamics of quantum systems, and (3) results relating to the processes driven by solar energy. These areas have all been significantly impacted by the ideas and methods of the finite-time thermodynamics and some mention of them in the book would have been desirable. It is true, however, that inclusion of these topics would have forced the already 500 page book to be significantly longer, and this fact probably played a significant role in the authors' decision to omit these topics.

Finite-time thermodynamics is not a mature field. The present text represents a real step forward in collecting so many results and putting them into a cohesive framework presented at the level of detail that a student willing to put in some effort could follow. The field holds great promise not only for industrial systems, which the authors' analysis treats well, but also for biological systems, quantum systems and for the general understanding of our universe. In summary,