BOOK REVIEWS

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Understanding Process Integration II

Editor	Robin Smith
Publisher	Hemisphere Publishing Company, New York (1988)
Pages	360
Price	$79.00
Reviewer	D. William Tedder

This volume consists of 17 papers selected from a 2-day symposium organized by the Institution of Chemical Engineers (Northwest Branch) and held at the University of Manchester Institute for Science and Technology, March 22-23, 1988. It is of primary interest to engineers who are concerned with energy management strategies, particularly as they might be applied in cogeneration applications. Many of the papers have an operations research flavor. Virtually all of the examples are taken from the hydrocarbon processing industry.

Process integration is a subtask of process synthesis as originally described by Rudd,[1] Masso and Rudd,[2] and Rudd et al.[3] Synthesis is the act of "discovering" new and improved process flow sheets that solve a particular design problem. Synthesis (or design) tasks include such activities as selecting various unit operations and processing technologies, finding efficient methods of linking unit operations into a processing network, and integrating the network to minimize heat transfer utilities (e.g., cooling water, refrigeration, and process steam usage).

Since Rudd first suggested process synthesis as a research area, two general solution strategies have evolved. Problems can either be addressed heuristically (i.e., using various empirical rules-of-thumb) or else algorithmically. Heuristic methods are generally simpler to implement and easier to understand, but they are also less precise and often ambiguous. Typical separation heuristics include simple rules such as "remove the most plentiful component first" or "do the difficult separation last." Algorithmic synthesis methods are usually operations research applications with innovative or insightful twists leading to improved solutions. Algorithmic synthesis methods typically involve the use of dynamic programming, mixed integer programming, or branch-and-bound strategies. Some investigators have advocated combined heuristics and algorithmic methods where a hierarchy of design strategies are implemented sequentially.

Although both heuristic and algorithmic methods are discussed, the primary focus of this book is on the latter area and, in particular, the design of energy management networks that support chemical processing activities. In the simplest case, sensible heat is transferred from hot processing streams that require cooling to cold processing streams that require heating. The primary goals are to maximize the amount of heat that is transferred between processing streams and to minimize the number of heat exchangers in a network. This strategy minimizes the residual utility requirements (e.g., cooling water, refrigeration, and stream) and the capital investment to construct the network.

Most of selected papers (10 of 17) are related to a particular algorithmic method—the "pinch technology" heat exchanger network design method that was pioneered by Linnhoff. They generally assume that the reader has a working knowledge of key terms (e.g., problem tables and grand composite curves) that are not defined in the book[a] and is familiar with pinch technology. O'Young, Jenkins, and Linnhoff, for example, formulate the pinch table for cases where there are network constraints. (The original analysis assumed that the heat exchanger networks were unconstrained.)

In all, Linnhoff is a contributor to 4 of the 17 chapters. Of these contributions, the paper by Linnhoff and deLeur is perhaps of greatest interest to *Nuclear Technology* readers. They examine the strategic use of furnaces to reduce total energy usage in an application and point out that combustion air should always be preheated to the cold pinch temperature to achieve maximum furnace efficiency in a network.

There are additional contributions that describe the application of pinch technology to specific problems, its extension to new problems, or address related issues. For example, Reimann and Steiner examine a related issue, the stability of networks that have been designed using pinch technology. They present two design aids—a set of simple rules and formulas, and a dynamic simulator for modeling networks. They

[a]Douglas gives an introduction to heat exchanger network design in Ref. 4.

conclude that networks that have been designed using pinch technology have good controllability.

Kotjabasakis and Linnhoff present a case study in process flexibility (i.e., debottlenecking and catalyst fouling) and, in a somewhat related paper, Linnhoff et al. further extend this analysis to examine batch processing. In this latter paper, their analysis considers debottlenecking and energy integration as simultaneous goals. Here, they are trying to increase batch throughput rates and flexibility, as well as reduce energy usage.

Kemp and Macdonald also analyze batch processing. They describe methods that identify process changes by splitting the grand composite curve and they provide a more rigorous targeting method.

Rossiter and Ranade discuss the use of marginal costs for analyzing retrofit costs, while Ranade and Sullivan describe software allowing the integration of heat pumps. These two papers describe results from work sponsored by the Electric Power Research Institute and will be of interest to readers who are concerned with cogeneration. Glavic extends Linnhoff's methods to systems involving heat engines and chemical reactors. This paper is also relevant for cogeneration studies.

Other algorithmic approaches to solving heat integration problems are presented by Dhallu and Johns, Ciric and Floudas, and Chang and Yu. For example, Dhallu and Johns evaluate heat integration in distillation networks. They present a new algorithm for solving the nonlinear, nonconvex, modified transportation problem that results from their analysis. Ciric and Floudas apply a two-stage procedure for addressing heat exchanger network problems in retrofit situations. Their technique utilizes superstructure analysis with mixed integer linear programming and nonlinear programming. On the other hand, Chang and Yu provide a third approach. They describe an evolutionary stream-merging technique to reduce the number of heat exchanger units without energy penalty or violating the minimum approach temperature.

Four papers are concerned with flow sheet development more than with integration per se. Lott describes the use of simulators as an aid to process synthesis. This paper appears first in the book and provides a short overview of synthesis. Dhallu and Johns describe a procedure using dynamic programming to synthesize distillation trains with heat integration. They deal with state optimization by discretizing their continuous variables (e.g., pressure). On the other hand, Kaibel considers the use of exergy in arranging distillation columns with low energy consumption while Floudas applies mixed integer linear programming and superstructure analysis to solve a multiple-feed distillation tower synthesis problem.

This book is a useful reference for engineers who are already familiar with pinch technology and have some background in process synthesis. It addresses many relevant questions such as batch processing, retrofit analysis, flexibility, controllability, etc. It will be particularly interesting to chemical engineers since most of the examples are taken from the chemical processing industry.

REFERENCES

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3. D. F. RUDD, G. J. POWERS, and J. J. SIIROLA, *Process Synthesis*, Prentice Hall, Englewood Cliffs, New Jersey (1973).

4. J. M. DOUGLAS, *Conceptual Design of Chemical Processes*, McGraw-Hill Book Company, New York (1988).

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Radioactivity and Health, A History

Author	J. Newell Stannard
Publisher	Battelle Pacific Northwest Laboratories (1988)
Pages	~2000
Price	$67.50
Reviewer	Hugh F. Henry

This is a *big* book—all 7 lbs. and almost 2000 pages of it. Prepared for the U.S. Department of Energy, the basic purpose of this book is to summarize the wealth of radiobiological information developed by U.S. government-financed experimental work for internally deposited radioisotopes and associated phenomena in the period from World War II (1940) through 1980. Thus, these data were obtained not only before the records thereof disappeared into some "never-never land," but also while some of the principal experimenters were still available for interviews. Since the author was an important figure in this effort, it is particularly fortunate that he was willing to undertake such a tremendous project. One can only thank him for a difficult job well done.

The material is presented in 21 chapters, which the author suggests may be divided into the following major categories:

1. naturally occurring radioactive elements
2. manmade radioisotopes
3. inhalation toxicology
4. environment
5. instrumentation
6. therapy and nuclear medicine
7. concluding comments.

Categories 1 and 2 are obviously concerned with uranium, radium, radon (and daughters), thorium, polonium, and plutonium, along with various actinides and fission products. The data are presented element by element for the laboratories involved, and with rather detailed descriptions and analyses of the methods used and the results obtained. Included