trate how physical properties remain constant over the range of small process disturbances. The important point to illustrate is the use of the ratio of the heat duty in the new case to that in the old case. Then it is seen that physical properties, which are assumed invariant, drop out of the ratio. It can also be shown that the ratios are actually easier to implement when using the LMTD method, as was used here, rather than the NTU method, even though the NTU method is often touted as the method of choice when outlet temperatures are unknown.

Students initially have two other misconceptions when confronted with this type of problem. One is the use of the energy balance alone, without the performance (design) equation. A key point is that there is existing equipment that behaves in accordance with the performance equation. Therefore, this equation must be included in the analysis.

The second misconception deals with the area of the heat exchanger. Another way to pose the problem is to ask whether the equipment can be used after the upset conditions, subject to a constraint. Let us assume that the constraint for the condenser is that the cooling-water return temperature may not exceed 50°C. A typical, initial student solution is to calculate the condenser area needed for the new case with the exit cooling-water temperature set to 50°C. If the calculated area is less than the existing area, then it is assumed that the equipment can be used. This is not true, however, since the solution to the problem shows that actual equipment performance will result in a temperature violating the constraint.

This type of problem can also be used as a creativity exercise since there are several ways to respond to the need for scale-down. As has already been seen (in the reboiler), the need to reduce the temperature difference can be accomplished by raising the pressure at the bottom of the column or by throttling the steam. Another possible response is to increase the reflux ratio to maintain constant flows and heat loads through the reboiler and condenser. Increasing the reflux ratio will result in increased product purity, which should not be a problem. Of course, this is not an economically attractive solution since the energy cost would remain constant with only half of the product revenue generated.

NOMENCLATURE

- A heat exchanger area (m^2)
- C_p heat capacity (kJ/kg°C)
- $\dot{m}$ mass flowrate (kg/sec)
- Q heat duty (W)
- s parameter defined in Eq. (10)
- T temperature (°C)
- λ latent heat (kJ/kg)

subscripts

- 1 refers to "original" case
- 2 refers to "new" case
- cw cooling water
- ℓn refers to log mean temperature difference
- ma maleic anhydride
- out refers to outlet temperature
- pa phthalic anhydride
- stm steam

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ChE book review

PROCESS HEAT TRANSFER

by G.F. Hewitt, G.L. Shires, T.R. Bott

Published by Begell House, CRC Press, Inc., 2000 Corporate Blvd., Boca Raton, FL 33431; 1042 pages, $75 (1994)

Reviewed by

Stuart W. Churchill

The University of Pennsylvania

The first two authors are located at Imperial College of Science, Technology and Medicine, and the third at the University of Birmingham. Despite their academic positions, they are well known for their expertise in applied heat transfer.

The objective of the authors is stated in the Preface to be

> *. . . to provide a book that will serve as a textbook at the undergraduate and postgraduate level and that can also serve as a general source of information for engineers in the process industry.*

In the view of this reviewer, the book completely misses the target in the first respect, but is a worthwhile contribution in the second. The long second chapter on "Mechanisms of Heat Transfer" is intended to provide a background in the fundamental aspects as an introduction to students and as a review and source of reference for practitioners. The treatment is inferior to that of most true textbooks on heat transfer and even to that in competitive books, such as the *Heat Exchange Design Handbook.*[1] Since most curricula in the United States offer only limited instruction in the detailed design of heat exchangers, this book does not appear to have much of a role as a textbook in that context either. It will, however, be an essential reference book for courses in process design at both the undergraduate and postgraduate levels.

Continued on page 275.

obviously have different resources and could result in frustration when the students find that some opportunities are not available at their school. This chapter also includes sections on resumes and interviewing techniques that are important to freshmen, but which are often not covered.

Much of the last chapter, "Orientation to the Engineering Education System," appears to go beyond the freshman's need to know. This includes information on ABET, community colleges, grading systems, and the role of research. The statement

> *The first two years of engineering study at a community college are similar in almost every regard to the first two years of engineering study at a four-year institution.*

may mislead students. In my experience, students find studying engineering at a major research institution much more intense than at a community college. The sections on advising (it is a student's responsibility to find out), the importance of grades (since it is quantitative, GPA is heavily weighted), academic dishonesty (ethics is not always clear-cut), and graduate study (never too early to think about it) are well done.

The general quality of this book is high. It is nicely printed with a pleasant soft cover. Many of the problems at the end of the chapters are well thought out and will be thought-provoking, although a few ask for too much ("write a 500- to 750-word essay . . ."). The lack of an index will unfortunately discourage browsing. The price seems reasonable.

Engineering professors teaching engineering orientation courses should obtain and read a copy of this book. I would strongly recommend it to engineering students for supplemental reading of Chapters 1, 3, and 4. ❒

REVIEW: *Process Heat Transfer*

Continued from page 243.

The book is perhaps best interpreted as an update of the book of the same name by D.Q. Kern.[2] In this regard, it is highly to be recommended. Conventional heat exchangers are described in structure and function, and their design is well illustrated by detailed examples. A few illustrative problems are included with most chapters.

The coverage and focus of the book is perhaps best indicated by the following chapter headings:

3. Basic Theory of Heat Exchangers
4. Selection of Heat Exchangers
5. Double-Pipe Heat Exchangers
6. Shell-and-Tube Heat Exchangers
7. Plate-Fin Heat Exchangers
8. Plate-and-Frame Heat Exchangers
9. Air-Cooled Heat Exchangers
10. Two-Phase Flow
11. Boiling Heat Transfer
12. Heat Exchangers with Vapor Generation
13. Steam Generators
14. Reboilers
15. Evaporators
16. Condensation
17. Heat Exchangers with Vapor Condensation
18. Shell-and-Tube Condensers
19. Air-Cooled Condensers
20. Condensation in Plate-and-Frame Plate-Fin Heat Exchangers
21. Direct Contact Heat Transfer
22. Direct Contact Condensers
23. Water Cooling Towers
24. Furnaces
25. Heat Transfer Associated with Thermodynamic Cycles
26. Process Integration
27. Fouling of Heat Exchangers
28. Enhancement of Heat Transfer
29. Regenerative Heat Exchangers
30. Electrical Heating
31. Heat Transfer in Agitated Vessels

Some topics are conspicuous by their absence or by their minimal treatment, including: flow and heat transfer in porous media and in fluidized beds; heat transfer to liquid metals, in particular in nuclear reactors; heat transfer in high-velocity (compressible) flows; heat transfer with freezing; and materials of construction. The new frontiers of heat transfer such as solid-state processing, biological processing, and atmospheric modeling are not mentioned. Most surprising is the absence of any discussion of computer simulation of design except for a brief reference in the chapter on process integration. Qualitative considerations and rules of experience are given only minimal attention. The book by Gupta[3] provides a valuable supplement in that regard.

The book uses SI units and the new international standards on nomenclature. This may prove to be a nuisance for the present generation of practitioners, but is appropriate for future use since most students are now being instructed in these terms.

Although this review has focused on the contents and particularly on the omissions, the authors are to be commended on their achievement in the practical sphere. The book is well written, relatively free of errors, and readily accessible at all points without back-referencing. It deserves to be on the shelf of every designer of heat exchangers, of every teacher of heat transfer, and of every engineering library. In this regard it is a completely successful and essential replacement for its predecessor.[1]

References

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3. Gupta, J.P., *Fundamentals of Heat Exchanger and Pressure Vessel Technology,* Hemisphere Publishing Corp., Washington, DC (1986) ❒