specific methodologies. Feedback and open-ended problems are essential.

Recommendation 3

The AIChE design contest problems are prepared very thoughtfully by outstanding design engineers. These industry experts make sure that the design problems are realistic and contain "traps" for the naive and unwary. In the 1986 contest, forty-four student solutions were submitted but only five did not commit some fatal mistake, such as extrapolating a vapor pressure curve below the freezing point [6]. Surely the place for learning such facts of life is in the classroom and not on the job. AIChE devotes a session at the annual meeting to the design contest, and the contest problem, the first-prize solution, and the judges' comments are published (*e.g.* AIChE, 1985). However, expansion of the judges' comments and publication in a more widely-circulated journal such as *Chemical Engineering Education* would be very helpful.

Recommendation 4

In the past chemical engineering has "missed the boat" in aerospace, process metallurgy, pollution control, *etc.* We must not let current and future opportunities such as biochemical and electronic-component manufacture slip away.

Recommendation 5

Senior students with three full years of fundamentals (mathematics, basic sciences, engineering sciences, computer programming) will not automatically start designing and innovating the moment the first capstone design course begins. Nor will graduates with four years of fundamentals magically become design engineers their first day on the job. Early and repeated exposures to the "engineering facts of life" are essential.

We must never forget that far, far more BS graduates work in design, manufacturing, sales, technical services, operations, and troubleshooting than in research. Let us put student welfare first and make sure that all accredited undergraduate programs contain a truly meaningful design experience.

ACKNOWLEDGEMENTS

The author thanks all those colleagues who so kindly and generously provided their inputs. However the opinions expressed herein represent the views of the author and do not, at this time, reflect any official position of AIChE's Education and Accreditation Committee.

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ChE book reviews

ENGINES, ENERGY AND ENTROPY

by John B. Fenn
W. H. Freeman and Company, 1982,
288 pages, $12.95 paper

Reviewed by
John P. O'Connell
University of Florida

"Thermodynamics is a state of mind," one of my colleagues has said, referring to the fact that the desired approach to and understanding of this noble human construct depends on one's personal taste as much as anything else. Thus, the plethora of available beginning treatments range from the mathematical and abstract, such as the impressive work of C. Truesdell, to the historical and physical, such as this charming book by Fenn, and all have at least a few champions.

Fenn's apparent objective is to make plausible and understandable the needs and uses of thermodynamic properties and analysis in two ways. One is his direct connections to the reader's everyday experience, and the other is his incisive descriptions of the evolution of thought from the rudimentary observations of cavemen, represented by Charlie (who is shown in comic

Continued on page 100.

ganized energy transfer (work) and would result in a temperature increase except for the fact that the diathermal walls allow for contact between two randomly distributed systems. Since the work transfer tends to push the temperature up, the natural "flow" of "randomness" will be away from the gas towards the external bath. Hence, as far as the system of gas in concerned, the isothermal compression has resulted in a net decrease of randomness, hence a decrease of entropy. This is also evident since the temperature has stayed constant while the volume has decreased.

Finally, the isobaric process A-E results when a gas confined to a container with diathermal walls is compressed and also immersed in a variable temperature bath which is adjusted so as to keep the internal pressure of the gas constant. Again, the compression results in an organized transfer of internal energy (work) tending to increase the temperature. In order for the system to retain constant pressure, however, it is necessary for the increased internal energy to escape via the only route available to it, *i.e.*, the random distribution contact with the external bath. Not only must there be such a contact, but the bath must be adjusted so that the temperature actually decreases. This results in a doubly intense outward "flow" of internal energy via the random distribution mechanism (heat). Hence, the entropy of the system actually decreases more than in the isothermal case. Also, since both the volume *and* temperature decrease for this process, it is clear that the entropy decrease is greater than for the previous case.

Of course, all of these examples have been previously described [2] in terms of pressure effects. The purpose of this set of descriptions has been to extend the gas kinetic ideas to the very difficult concept of entropy.

CONCLUSION

Definitions of internal energy allow for direct connection to the macroscopic thermodynamic quantities commonly sought by scientists and engineers. The aim of this work has been to demonstrate a simple connection between molecularity (as contained in gas kinetic theory of distributions) and macroscopic quantities such as entropy. It has been shown that entropy, defined as a measure of randomness relative to some reference condition, can be easily interpreted in terms of the distributions and how they change. "Flow" of "randomness" due to different interactions betweeen systems clearly helps to explain entropy changes. While this approach may not simplify the actual calculations required in applications of thermodynamics, it is hoped that it provides a satisfying semi-quantitative explanation of the inherent connection between molecular mechanics and macroscopic thermodynamic quantities.

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REVIEW: Engines, Energy, Entropy

Continued from page 93.

drawings with clever poems on most pages), to the ideas and results of the great thermodynamicists of the 19th Century. Further, everything is given to accomplish the essential calculations for thermal processes of all types. Thus, anyone with college level experience and intelligence can calculate the efficiencies of the various automotive engine and heat pump cycles without knowing either logarithms or integration beforehand—even their basics are included.

This is not to say that the book is superficial or incomplete (except that it is restricted to constant-composition systems). The order of contents is ancient observations, temperature, systems and states, work, heat, cycles (including Carnot's), energy, heat engines, entropy, and followed by appendices on mechanical properties, logarithms, entropy as a property, atomic weights and symbols. Each chapter has useful and enjoyable worked examples and problems whose answers are given in the back. I found the introduction of entropy quite nice since energy had previously been revealed as a quantity we use merely for keeping track of observations in a special way, and the distinction of heat and work had been carefully established. Then the desirability for having another state property of the special form $\delta q/T$ could be easily justified by several rigorous, but simple and novel, physical processes and mathematical relationships. Unlike the discussions of some others, I found the portions devoted here to the treatments of temperature scales, pure component phase behavior and thermodynamic cycles to be interesting and in excellent balance with the more intriguing historical, mathematical and molecular discussions. I would expect the book to be challenging to students, but also not expect to hear any complaints about obscurity or loftiness.

While the book could not serve as the only text for an engineering course, I recommend that all instructors of beginning engineering thermodynamics have a copy in their library and consider it for either a supplementary required book or a reference for their students to access. Teachers will find it a valuable resource for correct citations of thermodynamic history, for good concepts, developments and problems for beginners and for enhancing their own appreciation of the wondrous breadth of possibilities that thermodynamics allows in pedagogy and application. It may also be the best way to help that not-so-small set of students whose understanding depends on concrete physical examples and straightforward discussion in a text they can hold in their hands as much as, if not more than the sophistication and beauty of the logic described by their instructor. □

INTEGRAL METHODS IN SCIENCE AND ENGINEERING

Edited by F. R. Payne, C. C. Corduneanu, A. Haji-Sheikh and T. Huang
Hemisphere Publishing Company, 1986, 653 pages, $95.50

Reviewed by
Anthony G. Dixon
Worcester Polytechnic Institute

This is a proceedings volume of the first international conference on global techniques, held at the University of Texas at Arlington in March, 1985. The main emphasis of the conference and its proceedings was and is global solution methods, such as the finite element method (FEM), boundary elements (BEM) and integral transforms, to name a few. A second emphasis is the application of such methods to a wide variety of physical problems, of which those in the fluid mechanics and thermal sciences areas are probably of most interest to chemical engineers.

The book contains fifty papers and two synopses, arranged into six topic areas: mathematical physics, mathematical analysis, fluid mechanics, solid mechanics, thermal sciences and finally optimization and population dynamics. Some unity with areas is attempted by means of a summary by one of the editors, before the papers for each area. Given the aim of diversified applications, however, this is not very successful.

The volume itself is attractively bound and well-presented. The papers are not in a standard type, being reproduced from camera-ready copy, but apart from one or two cases they are clearly laid out and easy on the eye. The writing styles vary widely, from introductory (as in Payne's advocacy of direct formal integration [DFI] methods) to the very abstruse "theorem-proof" layout of one or two contributions in the mathematical analysis section.

I do not believe this book would be suitable as a main text for any chemical engineering or applied mathematics course, due to its diversified nature. It is unlikely that there is *enough* of interest to any one reader to warrant the $95 purchase price. On the other hand, there will be *something* of interest to anyone using mathematical methods in engineering. A copy should be available in the library of any educational institution, from which judicious selections could well enhance graduate courses in applied mathematics, fluid mechanics or heat transfer. □

ChE books received

Seventh Symposium of Biotechnology for Fuels and Chemicals, edited by Charles D. Scott; Wiley Interscience, Somerset, NJ 08873; 741 pages, $84.95 (1986).

Design of Devices and Systems, by William H. Middendorf; Marcel Dekker, New York, NY 10016; 456 pages, $35 (1986).

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High Temperature Heat Exchangers, by Mori, Sheindlin and Afgan, published by Hemisphere Publishing, 79 Madison Ave., New York, NY 10016; 606 pages, $95.00.

Heat Exchanger Sourcebook, edited by J. W. Palen, published by Hemisphere Publishing, 79 Madison Ave., New York, NY 10016; 805 pages, $59.95.

Managing Steam: An Engineering Guide to Commercial, Industrial and Utility Systems, edited by Jason Makansi, published by Hemisphere Publishing, 79 Madison Ave., New York, NY 10016; 224 pages, $37.95.