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BOOK REVIEWS

W. Z. Black and J. G. Hartley, **Thermodynamics.** Harper & Row, London, 1985, 755 pp., £14.95

The authors of this beautifully-produced book must have given up the struggle to find a title which is both helpful and different from those of the many similar textbooks in print! However, a quick browse confirms that the book consists of a more-than-adequate coverage of classical thermodynamics for the non-specialist parts of an undergraduate engineering course, and that it is most appropriate to students of mechanical engineering. The 13 chapters, in order, deal with: fundamental concepts; properties of substances; mass conservation; energy conservation (referred to on only one occasion as the first law; entropy and the second law; second-law analysis; gas cycles; vapour cycles; thermodynamic relationships; real gases; gas and gas–vapour mixtures; chemical reactions (effectively limited to combustion); chemical equilibrium. Those who consider the theory of turbomachinery and of compressible flows to form natural parts of a thermodynamics course will have to look elsewhere. Each chapter ends with a concise and useful summary of the ground covered, followed by a large number of problems derived where possible from practical engineering applications. (A solutions manual is mentioned in the preface, without any indication of whether this is also to be published.) S.I. units are used throughout. A bibliography and a typical selection of property tables and charts are included.

Two features of the book distinguish it from its predecessors. First is the strong emphasis on organizing a problem for systematic application of thermodynamic principles; a section of Chap. 4 is devoted to this point and its recommendations are followed in the many worked examples to be found in this and subsequent chapters. Second is the early extension of material on the second law to cover availability and related quantitative measures of the effects of irreversibility, and the use of these concepts in the chapters on cycle analysis. Most teachers will welcome the first of these features; however, those who are less than enthusiastic about the practical value of second-law analysis, in a 'core' thermodynamics course or even in engineering practice, may find that its introduction before simpler concepts such as isentropic efficiency (regrettably called adiabatic efficiency) serves only to confuse.

The material is not always as well ordered as it might be. For example, enthalpy is introduced well before the first law for flow processes, which ought to be the justification for its definition; the term 'irreversible work' occurs before the concept of reversibility. A practice which some teachers will regret is the use of the term 'open system' instead of 'control volume'. In the first chapter, the way in which electrical energy transfer is classified as work is rather unconvincing, but a valiant attempt is made to minimize the confusion which commonly arises when the terms 'heat' and 'heat transfer' are first introduced. On the credit side, in the reviewer's option, are the presentation and use of a general mathematical formulation of the second-law inequality for closed *and* open systems, and the handling of combustion using enthalpies of formation *and* enthalpy of reaction (avoiding the limitations of treatments which concentrate on one or other approach). On the whole, the presentation, including the illustrations, is good. The shaded backgrounds which emphasize the most important equations throughout the book will appeal particularly to students at the revision stage.

The overall approach of the book may be considered somewhat out of step with the trend (in the U.K., if not elsewhere) towards courses with more immediate industrial relevance. While its generally logical progression, from definitions through the laws of thermodynamics to applications, has been the traditional approach and one that can be successfully followed by the potential innovators in the upper part of the ability spectrum, there could with advantage have been more in the early chapters (by way of illustrations from engineering practice) to whet the appetite of the average student. Nevertheless, this is a book which can be recommended. It certainly represents good value for money.

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L. C. Burmeister, **Convective Heat Transfer.** John Wiley, New York, 1983, ix + 790 pp.

The aim of this well-written and well-presented book is to provide a textbook for students starting an engineering course. The author intended to establish a coherent base for the subject and, in my opinion, has succeeded.

The text consists of 14 chapters, with the following headings:

1. Introduction.
2. Kinetic Theory of Gases.
3. Transport Properties.
4. Equations of Continuity, Motion, Energy and Mass Diffusion.
5. One-dimensional Solutions.
6. Laminar Heat Transfer in Ducts.
7. Laminar Boundary Layers.
8. Integral Methods.
9. Turbulence Fundamentals.
10. Turbulent Boundary Layers.
11. Turbulent Flow in Ducts.
12. Natural Convection.
13. Boiling.
14. Condensation.

Seven useful Appendices, an author index and a subject index close the book. In the introduction the author presents the rate equations and the analogies between the transport properties. The treatment of convective transport begins in Chap. 2, at the molecular level for a gas, and continues in Chap. 3, where it is shown that the transport properties of mass diffusivity, thermal conductivity and viscosity naturally arise. In Chap. 4 the partial differential equations that describe the continuous fluids convective behaviour are derived and discussed. The major points discernible from the equations in Chap. 4 are emphasized by solution of well-chosen one-dimensional problems in Chap. 5. They include Couette and Poiseuille flows and Stefan's diffusion problem. Chapters 6–8 extend the forced-convection considerations to laminar flows in ducts and boundary layers; adequate consideration being given to such interesting topics as variable-property effect on boundary layer, similarity solution for flow over a wedge, transpiration on a flat plate, finite-difference solutions, and integral methods. Chapters 9–11 deal with forced turbulent flow in ducts and boundary layers, and include some of the most recent turbulence models (one- and two-equation), as well as finite-difference solutions. The last three chapters (12–14) are devoted to natural convection, boiling and condensation.

The useful appendices contain elements of vector analysis, heat and mass diffusion in anisotropic materials, elements of non-Newtonian fluids, the conservation equations in Cartesian and cylindrical coordinates, similarity transformation by separation of variables and Taylor and Helmholtz instability criteria, which are important in problems concerning an interface between two phases.

The above material is presented in a conventional but clear manner, and the strong point of this book is the extensive number of well-thought-out and practically interesting problems that follow each chapter, assisting the reader to digest the material and link it to practical applications. The literature cited is adequate but could be more extensive and up-to-date. Some more emphasis could also have been placed on the numerical computations feasible today, because of their current dramatic impact on the field.

The text design quality is good and the book is very well printed and illustrated. The material is particularly suitable for teaching courses at advanced undergraduate/graduate levels; and will appeal to lecturers who will find a generous stock of material to select, to suit the needs of their students. The book should also appeal to any practitioner of heat transfer as a reference test.

The book can be thoroughly recommended to both students and lecturers of courses in heat transfer.

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N. WAKAO and S. KAGUEI, **Heat and Mass Transfer in Packed Beds.** Gordon & Breach, London, 1982, xxii + 364 pp.

THIS BOOK is part of a series of monographs and texts edited by R. Hughes, under the general title of *Topics in Chemical Engineering*. This series is planned as a number of books covering areas of chemical engineering which, although important, are not treated at any length in standard texts. This is certainly the case with the problem of heat and mass transfer in packed beds, which because of their heterogeneity and complexity have not lent themselves to the application of exact hydrodynamic theory. The authors hope that this book will help graduate students and researchers in chemical engineering understand the relevant phenomena; and, in my opinion, they have done a commendable effort towards that purpose.

The text is arranged in eight chapters, with the following headings:

1. Parameter Estimation from Tracer Response Measurements.
2. Fluid Dispersion Coefficients.
3. Diffusion and Reaction in a Porous Catalyst.
4. Particle-to-Fluid Mass Transfer Coefficients.
5. Steady-state Heat Transfer.
6. Thermal Response Measurements.
7. Unsteady-state Heat Transfer Models.
8. Particle-to-Fluid Heat Transfer Coefficients.

Three appendices, and author and subject indices close the book.

In Chap. 1 the techniques of parameter estimation from the measurements of tracer input and response signals are discussed. These techniques include moment and weighted-moment methods, curve fitting in the time domain, transfer-function fitting, Fourier analysis, etc.

It is recognized that conversion in a chemical reactor depends largely on the degree of fluid dispersion in the reactor. With this in mind, the authors devote Chap. 2 to the effect of dispersion on chemical conversion, the significance of fluid dispersion coefficients and their evaluation in reactive, non-reactive and adsorption-packed bed systems. The importance of the catalyst effectiveness factor, the mechanisms of pore diffusion, the measurement and prediction of effective diffusivities in porous solids and multicomponent systems are discussed in Chap. 3.

Chapter 4 presents a critical review of the published particle-to-fluid mass transfer coefficient data and their correction for axial dispersion effect. Chapter 5 is devoted to packed beds used as heat exchangers, under steady-state conditions. Analytical solutions for temperature profiles are presented, together with various empirical formulae for the prediction of effective thermal conductivities and wall heat transfer coefficients.

Chapter 6 outlines the techniques for parameter measurement by thermal response, and the prediction of fluid thermal dispersion coefficients from axial effective thermal conductivity by model comparison. The last two chapters (7 and 8) are devoted, respectively, to describing models of unsteady-state heat transfer and to reviewing the published particle-to-fluid heat transfer coefficient data.

Appendix A contains physical property data and units conversion factors. Appendix B lists computer programs, in FORTRAN 77, for predicting a response signal and calculating the RMS errors for construction of a two-dimensional error map.

Finally, Appendix C presents a computer program for deriving the moment equations for infinite adsorption beds, and for adsorption/dead volume system.

The above material is presented in a conventional, clear, manner; but I would have preferred a somewhat different chapter organisation (such as 1–2–4–6–8–3–5–7 or 3–5–7–1–2–4–6–8), although the interspersion of 'theory' and 'measurement' chapters is not at all disturbing.

The literature cited is adequate but could have been more extensive; and inclusion of some discussion on the mathematical modelling and computation of packed beds which is feasible today, should also be considered in a future edition.

The book is well printed and illustrated and comes bound in an attractive red and black cover.

The material is very suitable for teaching courses at graduate level, and also as reference for any chemical engineer. The book can, therefore, be recommended to both students and lecturers of relevant courses, and to any practitioner of heat and mass transfer.

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