

written (!) solution manual accompanying the main text. Although it may be considered an added bonus to the buyer, its presentation is still unjustifiably poor. I sincerely hope that in a future edition it will be properly printed, to the same high standard of the main text. This aside, the book can be thoroughly recommended to both students and teachers of undergraduate courses in heat transfer.

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ADRIAN BEJAN, *Entropy Generation Through Heat and Fluid Flow*. John Wiley & Sons, New York, 1982, 248 pp., £33.00.

ACCORDING to the preface "this book is [the author's] attempt both to inform and persuade those who work in heat transfer of the increasing importance of thermodynamics in their field". He claims that such enlightenment is needed most everywhere (i.e. with the possible exception of M.I.T.). The book is "designed to bridge the gap between three cornerstone subjects: heat transfer, thermodynamics and fluid mechanics". No small task for a book this size. This 'gap' (if you must know) is 'bridged' by the subject of entropy generation, which, somehow (see Diagram 2 and the jacket illustration), fits in snugly (like a triangle) where the three aforementioned topics would otherwise coalesce at a point. (The exact meaning of this symbolism escaped me.)

Chapters 1 and 2 deal with semantics. Here they all are: the 'availability', 'least available work', 'exergy' and, of course, the 'energy of enthalpy'. There is not much new in terms of physical insight but it is probably useful to have the entire glossary displayed and defined in one place without any appreciable bias on the part of the author.

I would now advise the student reader to go on with Chapters 5–11, which contain applications of 'second law analysis' to various situations including heat exchangers (Chapter 7), cryogenics (Chapter 10) and solar energy (Chapter 11). Realistic engineering design problems are included here and there. These chapters provide a fresh and interesting introduction to several applications and could profitably be used to supplement advanced undergraduate and introductory graduate courses in thermal science.

Those readers with prior knowledge of fluid mechanics, in particular hydrodynamic stability theory and prevailing ideas about the onset and development of turbulence, are invited to embark on Chapters 3 and 4, the main exposition of fluid flow theory. Shall we laugh or shall we cry? Here in twenty-odd pages the author claims to have "explained theoretically the origin of:

The meandering course of rivers, plumes and other large Reynolds number flows...
 the vortex shedding phenomenon...
 the transition to turbulence in shear flow...
 the bursting of turbulent boundary (wall) layers..."

just to mention a few. It is all based on the author's "buckling theory of turbulence" and it (quite obviously) is not very convincing. A gap to bridge? A bridge too far... Students beware.

Chapter 12 (the last one) is on energy policy and is by Mary Bejan. I would have left it out as well.

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E. U. SCHLÜNDER, K. J. BELL, D. CHISHOLM, G. F. HEWITT, F. W. SCHMIDT, D. B. SPALDING, J. TABOREK, A. ZUKAUSKAS and V. GNIELINSKI (Editors), *Heat Exchanger Handbook*. Hemisphere, 1982, 2080 pp., \$600.00.

THIS monumental work of over 2000 pages with numerous tables and figures covers the whole field of heat exchanger design, from the basic science to practical aspects. It is difficult in one review, or indeed for one reviewer, to do justice to every part of the work, and detailed commentary and criticism of each section is probably better left to users and specialists. This could perhaps be organized after a short period of time when those in industry and research establishments have had the opportunity to use the handbook.

On the broader front, one's first reaction is to be reminded of the massive addition to knowledge of heat and mass transfer gained in the last 50 years or so. This period happens to coincide with my own active life in engineering science, and on a personal note I well recall the comment of Sir Frank Smith, then Secretary of the British Department of Scientific and Industrial Research, on hearing that Margaret Fishenden and I were writing our first book on *The Calculation of Heat Transmission*; he said "heat transfer seems to me a rather elementary subject". How wrong he was!

Why is the subject so difficult and the literature so voluminous? There are two answers, one scientific the other practical. Scientifically, heat transfer is concerned with the rates of action of irreversible thermodynamic processes which need to be described quantitatively in terms of equilibrium properties such as temperature and pressure, and the various specific properties of solids and fluids. Unfortunately those processes, mainly types of diffusion, take place under many different complicated conditions including fluid flows, often three-dimensional and time variant, in a wide range of geometrical boundary conditions. Practically, heat exchangers are required in a wide range of engineering plants including new developments. As in other branches of engineering development, heat exchangers were designed quite successfully using only elementary scientific data, before the advances in heat transfer science, but efficiency and performance have since been greatly improved. It will be a long time before they are designed entirely on scientific data, in fact this is unlikely, because there is a strong element of art in design, based on experience. There is always scope for innovative and imaginative thought, which does not come from calculations alone, although these are valuable in making comparisons. This is not to deny the need for a sound basic approach, and the handbook is likely to become an essential reference for all engaged in industrial design and in applied heat and mass transfer research.

The book is well set out, with good indexing, and remarkably free from misprints and errors. Owing to the need to make each part self-contained there is a certain amount of duplication of pages and repetition in the text, but for so large a book it is relatively easy to find one's way about.

Turning briefly to the sections, Vol. 1 contains definitions, basic equations and their solution, set out with immaculate precision, and a section on heat exchange charts. This is textbook material, but in a form useful for reference, and includes a large number of references for further reading.

Volume 2 entitled *Fluid Mechanics and Heat Transfer*, which includes radiation, is the longest of the five, and presents what is usually regarded as the science of applied heat transfer. It would take a long review to cover the whole volume, which might be undertaken separately, perhaps by more than one specialist. It starts with a welcome clarification of the roles of conduction and convection, the latter without the former being akin to a transporting organization which can deliver the goods but cannot unload them. The volume includes single phase flows, boiling, condensing, evaporation and gas-solid systems, but wisely stops short of more exotic processes such as flame radiation in furnaces, combustion, or high-speed flows. The book is mainly concerned with conventional heat exchangers, and this is to be welcomed.

Volume 3 on Thermal and Hydraulic Design is probably the most difficult to present because, in contrast to Vols 1, 2, and 5 which are scientific information, Vol. 3 includes general discussion of the approach to design and methods used by designers and practical aspects. But this volume is likely to be of particular value to all users. The difference is apparent in the presentation, Vol. 3 consisting of separate articles by a number of experienced engineers each giving their own views, with a certain amount of overlapping. The 'art' aspect of design first appears here. A wide range of types of heat exchangers is described, and specialists will find interest in general reading as well as in their own field. Many types are dealt with only briefly, as for example specialist boiling equipment, regeneration, and furnaces.

It would be interesting to have had more information from experienced designers on practical aspects of fouling, reliability, overhaul and maintenance, environmental effects and general experience of operation.

Volume 4 entitled Mechanical Design of Heat Exchangers, although similar to Vol. 3 in that it includes both theory and practice, is easier to present because much of it deals with design problems more familiar to engineers generally, such as choice of material, stressing, fabrication, testing, vibration. Several contributors give useful accounts of methods used, and included are some special types such as cooling towers and agitated vessels. The scope for future extension is considerable, especially if experienced authors from different industries and countries can be brought in.

Volume 5, on Properties of Fluids and Solids, is more straightforward and easier to present because it consists of scientific data, but it will be of great value especially since it includes many newer fluids. It brings together data not easy to find, and is certainly one of the most important parts. The layout is good, and the lists of references and index will be much used.

In conclusion, the handbook does credit to the team which conceived the project, and brought it to reality, a big task which must have involved a lot of time and effort.

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R. H. S. WINTERTON, *Thermal Design of Nuclear Reactors*. Pergamon Press, Oxford, 1981, 200 pp., £7.50.

This book, of about 180 pages, consists of two introductory chapters, six chapters dealing with the principles of thermal design and their application, and two final chapters dealing with peripheral issues.

The first chapter sets out the necessary reactor physics and the second describes the main reactor types, namely PWR, BWR, AGR and sodium cooled FBR, in sufficient detail to act as a foundation for the rest of the book. Both introductory chapters suffer from being short.

Of the six chapters dealing with the main theme of the book, three set out the groundwork of heat transfer and fluid mechanics and three deal with its application to 'fuel rod design', 'safety analysis' and 'core thermohydraulic design'. I think it is a pity that the groundwork is not based on the unified approach offered by the continuity, Navier-Stokes and energy equations; instead radial conduction and fluid flow are developed from first principles and forced convection is treated using the π theorem. No doubt, two-phase flows are adequately dealt with using this approach, and the author did not aim to cover numerical prediction methods for which the governing equations are necessary. However, forced

convection represents a significant part of the book and in my view is rather sterile because of the approach adopted.

The application of the groundwork is either by correlations or simple physical models. The reader is steered very well through the maze which the prediction of two-phase pressure drop often presents to the uninitiated, and some advanced topics are dealt with. The penultimate chapter deals with the arrangement of steam cycles and the final chapter with fusion reactors. Problems and answers are given in Chapters 3-9 and some useful physical properties are included in appendices.

On the whole I found this an interesting and provocative book, perhaps too provocative in a few instances because of statements and generalizations which would require much effort to verify. It should prove useful in teaching final year undergraduate and postgraduate students, with more rigorous but much less readable textbooks in support.

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W. W. DURGIN (Editor), *Flow: Its Measurement and Control in Science and Industry*. ISA, Vol. 2, 1981, 867 pp.

This book documents the proceedings of the second symposium on 'Flow—Its Measurement and Control in Science and Industry', held in St Louis, Missouri, 23-26 March 1981. The first symposium (Vol. 1) took place in 1971 and it was the stated intention of the present symposium to focus on advances over the intervening ten years.

The papers proper are preceded by summaries of invited lectures in the areas of: flow measurement standards; accuracy; real fluid effects; standardization; and there then follow various invited panel reports.

The main body of the publication comprises some 65 papers under the following headings:

1. Flow Characteristics and Fluid Velocity Measurement Techniques—covering basic flow measurements in closed conduits and velocimetry instrumentation.
2. Fluid Metering and Control Techniques—involving a range of flowmeter applications, e.g. a differential flowmeter to sense differences of 0.1 ml in 1000 ml, valves and control, and pulsating/unsteady flow.
3. Flow Measuring Devices—dealing with differential pressure devices, critical flow venturis/nozzles, turbine meters, two-phase flow measurements, electromagnetic and ultrasonic flowmeters.
4. Environmental Flow Measurement—covering open channel flow measurements, e.g. in flat water surface gradients, and measurements in 'internal' flows, e.g. mine regulators.
5. Standards, Traceability, and Facilities—calibration and methods relating to liquids and gases.

As one would expect, the essential drive of all the papers is the accurate determination of flow and velocity in a wide range of situations. A number of interesting and unusual flow problems are considered.

The whole publication would benefit greatly from an index since the reader will inevitably be seeking information on specific subjects.

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