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BOOK REVIEWS

M. N. IVANOVSKII, V. P. SOROKIN and I. V. YAGODKIN, **The Physical Principles of Heat Pipes** (translated by R. Berman and G. Rice). Oxford University Press, New York, 1982.

THE NUMBER of books dealing with heat pipe technology is not large and therefore a new volume in this field is to be welcomed. This book is a translation of a Russian text, which was originally published in 1978 and this fact inevitably dates some of the contents. The Russian authors work at Physicoenergetics Institute of the State Committee on the Use of Atomic Energy and to a great extent this background is reflected in their selection of material.

The book starts rather inauspiciously with an unnumbered introductory chapter with numbered sections, 1.1, 1.2, etc. Then follows 'Chapter 1' with, of course, identical numbered sections 1.1, 1.2, etc.—a slight editorial slip-up here, I think.

In the following chapters the theory of heat pipe operation is considered in detail with approximately one third of the book concentrating on the hydrodynamics of liquid/vapour systems. Experimental results are also included to support the theoretical predictions. The majority of the results derive from tests with liquid metals, particularly sodium, and are therefore in a rather specialised field.

An appendix is included to demonstrate calculation methods for heat pipes. The appendix is rather unsatisfactory as it repeats some of the material presented in the previous chapters. The authors stress the advantage of using the computer for calculations and include several of their own programs as illustration. The programs are difficult to understand with no explanatory statements included in the listings to assist the uninitiated. It would have been far better to illustrate the calculation procedures with specific worked examples and leave out the program details.

Apart from these criticisms, the book is difficult to fault; the translation is excellent and reads very well indeed; quality paper, a clear typeface and good binding result in a very attractive book. A quality product from Oxford University Press at a quality price of £30.

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B. V. KARLEKAR and R. M. DESMOND, **Heat Transfer.** West Publishing Co., St. Paul, Minnesota, 1982, 2nd edn., xiii + 799 pp. + solutions manual, 417 pp.

THIS book is designed for a first-level undergraduate course in heat transfer, that can be used for a single course given in a quarter or a semester system, or as a two-course sequence in a quarter system.

The contents are organized in 11 chapters, with the following headings:

1. Introduction to Heat Transfer
2. Steady-state One-dimensional Heat Conduction
3. Two-dimensional Steady-state Conduction
4. Transient Heat Conduction
5. Numerical Methods in Heat Conduction
6. Thermal Radiation
7. Fluid Flow Background for Convective Heat Transfer
8. Forced Convection
9. Natural Convection
10. Heat Transfer with Change of Phase
11. Heat Exchangers
    Appendices: Appendix A–H
    Answers to Selected Problems
    Index.

Homework problems (both in English Engineering System and SI units) and references follow each chapter.

Chapter 1 presents a thorough introduction to the general subject, including conduction, convection, radiation, energy balance and the First Law of Thermodynamics. Chapter 2 deals with one-dimensional heat conduction, including systems with heat sources, a summary of thermal resistances, and heat transfer from rectangular, triangular and circumferential fins. Although not implied by the title, this chapter presents also the three-dimensional heat conduction equation. This equation is subsequently reduced to its one-dimensional form, and is applied to two of the one-dimensional problems considered earlier. From the teaching point of view this is useful, as it shows how the reduction process leads to the same differential equation, obtained by purely one-dimensional considerations.

Chapter 3 discusses two-dimensional conduction, including graphical analysis and analytical solutions. Chapter 4 contains material on transient conduction including chart and analytical solutions for plane wall, heat-balance integral and two- and three-dimensional transient systems. The next chapter presents numerical methods in heat conduction and is particularly well documented. It includes sample programs for computing the temperature distribution in a radial fin, for which the heat-transfer coefficient is a function of temperature, for a rectangular-plate problem and for a one-dimensional unsteady heat-conduction problem.

Chapter 6 is devoted to radiation, and Chapter 7 provides a fluid flow background to forced convection (laminar and turbulent flow in tubes, flow over a flat plate, integral and differential analysis of the laminar boundary layer, flows across a cylinder, a sphere and across banks of tubes). Chapter 8 is devoted to forced convection, including the presentation of design correlations for forced convection through tubes, over flat plates, across a tube and across tube banks. Chapter 9 deals with natural convection, presenting the integral method of solution and the differential formulation of the vertical wall problem; and design correlations for vertical and horizontal flat plates, inclined surfaces, rectangular blocks, spheres, vertical and horizontal cylinders.

Chapter 10 introduces the subject of heat transfer with change of phase (filmwise and dropwise condensation, boiling heat transfer) and Chapter 11 the analysis of heat exchangers (parallel-flow, counter-flow and multiple-pass heat exchangers, heat exchanger effectiveness, fouling factors for heat transfer surfaces and variable overall heat-transfer coefficient). The 13 appendices are devoted to units and dimensions, conversion factors and property values given in both English and SI systems of units. Answers to selected problems and a subject index close this book.

I particularly appreciate the way the authors have presented their material starting from specific situations, followed by their generalization. This philosophy is stated by the authors in the Preface to the First Edition and is followed throughout the text. I also share the authors' feeling that an engineering student who reads the material for the first time is lost, unless he is told beforehand the objective of the particular section and the ways or steps involved in achieving it. The text design quality is good, the book is very well printed and illustrated, and the sample problems as well as the homework problems are well thought out and interesting. There is also a handwritten (!) 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 'anergy 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.