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BOOK REVIEWS

F. MOSER and H. SCHNITZER, **Heat Pumps in Industry**. Elsevier, Amsterdam, 1985, 264 pp., $59.25.

THOSE of us who know a little about heat pumps think of them as being not very different from refrigerators: both are reversed heat engines using a 'refrigerant' as a working fluid; both take in heat at a low temperature and reject heat at a somewhat higher temperature. Refrigerators extract heat from a region to be kept cold, whereas heat pumps supply heat to a region to be kept warm, and there the difference ends. And the principal application that comes to mind is air-conditioning, where the same plant can be run as a heat pump in winter and as a refrigerator in summer. The authors of this book are concerned to dispel this simple attitude; they believe that heat pumps can be economically applied to many industrial processes which have no association with refrigeration and refrigerants, though so far it is the refrigeration know-how that has propelled the development of heat pumps. Their book is intended to form a link between those who could design and supply heat pumps for new applications if they knew where the demand lay and those who would be interested in applying heat pumps in new ways to their industrial processes if they were aware of the potential economic benefit.

In the first part of the book different cycles of operation are discussed and assessed in simple thermodynamic terms. The properties of different working fluids, including those of non-azeotropic mixtures, are reviewed; and criteria are put forward for matching the working fluid to the possible application. In the next part, an attempt is made to mark out the territory of potential applications by relating heat pumps to some particular unit operations of chemical engineering: evaporation, distillation, drying of solids and gases, and general heat recovery. Finally a range of specific industrial applications are presented as case studies, varying from polymerization processes to fish drying. The references are extensive and up to date.

There is not much here of specific interest to the heat transfer specialist; this discipline receives little attention, even in the context of the condensation and evaporation processes that are intrinsic to most practical cycles. No doubt the technique here can be taken for granted! But the book will surely be of value to anyone with an interest in the possibilities for heat pumps. The reader will have to cope with a certain lack of clarity both at a technical level and at the level of plain idiomatic English; and the appearance of the printed page, reproduced from typescript, is unattractive. But the price of these deficiencies is likely to be worth paying.

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W. A. DAY, **Heat Conduction Within Linear Thermoelasticity.** Springer, Berlin, 1985, 80 pp.

THIS book is a careful mathematical treatment of the (classical) one-dimensional linear theory of thermoelasticity. After a brief introduction, an investigation is made (Chap. 2) of the effect of thermo-mechanical coupling in isolation from the effect of inertia, i.e. a coupled quasi-static approximation is made. The consequences of this assumption are analysed by considering the one-dimensional case of a rod clamped at $x = 0$ and $x = 1$ with zero temperature at $x = 0$ and $x = 1$ and a specified initial temperature. With these assumptions the problem is reduced to an integro-differential equation for the temperature. The chapter pursues the solution of this equation in order to draw comparisons between this theory and the rigid conductor (for the classical heat equation). Chapter 3 continues to consider qualitative properties of the solution to the integro-differential equation and make comparisons with the classical uncoupled case, but with particular reference to trigonometric solutions.

In Chap. 4 the author returns to the full (one-dimensional) thermoelastic equations including inertia and considers the much used approximation of setting the coupling constant equal to zero in the 'heat' equation thus getting the standard heat equation for the temperature but a contribution from the temperature gradient still appears in the wave equation for the displacement. He then proves a result justifying this approximation. In Chap. 5 he proceeds to consider qualitative properties but now for the full coupled equations including the inertia terms. All of the above considerations are with respect to the one-dimensional rod problem.

The book is beautifully written and a scholarly account of the analysis of the integro-differential equations arising in the various approximations mentioned above. The drawback is of course that it is one-dimensional and at the back of this reviewer's mind is always the nagging question, 'Very nice but?'

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J. M. KAY and R. M. NEDDERMAN, **Fluid Mechanics and Transfer Processes**. Cambridge University Press, Cambridge, £17.50.

"ALTHOUGH design calculations in the real world of engineering have been almost entirely computerised in recent years", write the authors in their preface, "it is important that professional engineers should retain the ability to carry out quick-check calculations of a simplified nature". This book, a new one rather than an up-date of the successful earlier volume by the same authors, is designed to teach that ability.

I liked it, not least because its contents correspond uncannily well with the general knowledge which I had personally acquired about fluid mechanics and transfer processes by the time I started to teach at Cambridge in the 1950s. It is a body of theory which has served me well; and the authors have packaged it attractively. They start as I did: Goldstein's *Modern Developments*, Eckert and Drake's *Heat and Mass Transfer*, Bird, Stewart and Lightfoot, McAdams, Sherwood, and Schlichting; and from those well-tried works, and their own insights and experiences, they have put together a 600-page work of coherent, useful and digestible knowledge.

The book is also commendable, in my opinion, for what it does *not* contain. There are no Laplace transforms or Bessel functions in the heat-conduction section; turbo-machinery is handled without reference to activator discs; turbulence is discussed without mention of 'turbulence models'; and the dynamical theory of gases is discussed as though the great book of Hirschfelder, Bird and Curtiss was still unwritten. Very refreshing! I felt the years roll away as I turned the pages.

Of course, some of these absences mean that the reader must look elsewhere for guidance on how to enter the modern world; for this does not merely employ computerised formulae of the kind which Kay and Nedderman recite: its computer-simulation techniques are based on mathematical and physical concepts of a different kind. Never mind! If the authors have omitted much that is useful, everything that they *have* included is worth knowing; having made no attempt to 'keep up with the literature', they have not felt constrained to discuss subjects of merely ephemeral fashionability. At £17.50 or $29.95 (paper-back), this book can be recommended to students; and teachers can be beneficially reminded by it that fluid mechanics and transfer processes can be presented as essentially simple subjects.

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NAIM H. AFGAN (Editor), **Measurement Techniques in Power Engineering**. Hemisphere, Washington, DC. Distributed outside North America by Springer-Verlag, 1985, 356 pp.

THIS book is a collection of lectures prepared for the Advanced Course organised by the International Centre for Heat and Mass Transfer on measurement in power engineering, held in August 1983 in Dubrovnik. It is intended for engineers interested in the application of modern measurement methods and associated control techniques in power engineering. A rather general introduction to the field is provided in the first paper by the editor (Institute of Nuclear Sciences, Belgrade), whilst the last paper (De Witt, Los Alamos) provides a general summary of data acquisition systems for heat transfer measurements, with emphasis on interfacing and thermocouple performance. Between these two bookends are papers on applications in combustion (Kunitomo, Kyoto), water reactors (Hsu, Maryland and Hewitt, Harwell), liquid metal cooled fast breeder reactors (Sackett, Argonne), plasma (Soloukhin, Minsk), and a long paper on solar power (Hahne, Stuttgart). The problems are topical and there is minimal repetition of basic material.

Readers can imagine the many different techniques that are applicable under these headings and will, indeed, find most of them here albeit in a few cases abbreviated almost to the extinction point of true understanding, plus some new ones. In the last category for this reviewer were heated thermocouple void meters, the plugging temperature method of measuring impurities in sodium, and the lithium chloride hygrometer. Furthermore, it is clear that some standardisation is necessary of the test conditions for the pervasive flat plate solar collector.

In general the techniques are those of proven reliability and some of the more advanced ones still under development in the research context are, understandably, not featured. Thus thermocouples and conventional spectroscopy are well covered, but there is little on the more advanced laser-based sizing techniques. With this proviso, the book provides a good summary of all relevant, well-established techniques.

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