Int. J. Heat Mass Transfer. Vol. 14, pp. 1879–1880. Pergamon Press 1971. Printed in Great Britain

BOOK REVIEWS

MIKHAIL N. KOGAN, **Rarefied Gas Dynamics.** Computer Center, Academy of Sciences of the USSR, Moscow, translated from Russian. Translation Editor Leon Trilling, Department of Aeronautics and Astronautics, M.I.T., Cambridge, Massachusetts. Plenum Press, New York (1969).

WITH an extraordinary combination of personal research and exhaustive scholarship, Professor Kogan provides a smoothly connected account of the theory of rarefied gas dynamics, as it has developed over the past sixty years, up to about 1968.

He defines his subject as coinciding with the theory of the Boltzmann equation and of various models of that equation, with applications largely in the field of aerodynamics and heat transfer. A constantly and successfully emphasized theme is elucidation of the role of the hydrodynamic approximations (Navier–Stokes equations, etc.). The emphasis is nicely balanced between mathematical deduction and physical intuition. The range of topics and special problems will be quite familiar to any follower of the International Symposia on Rarefied Gas Dynamics.

The book makes three very strong impressions on me.

First it is *the* book to which the serious, and mathematically inclined, researcher can turn to prepare himself for work in this field. It is, however, not for the casual reader or the absolute beginner who hopes to skip through, to pick out a few results of special applied interest. This is not the fault of Professor Kogan, who argues with unusual clarity. It is simply that one's personal understanding of the Boltzmann equation depends on a gradual and patient assimilation of a great many special results and subtle concepts.

Second, its flavour is absolutely international. Professor Kogan is obviously completely at home with the work of Americans and other "foreigners", and his writing and style of analysis will seem not at all foreign to English-speaking readers.

Third, this book must survive as a classic of technical translation and meticulous editing. I am not competent to judge the linguistic accuracy of the translation, but it seems clear that we owe to Professor Trilling a final smoothness and clarity which could only be the product of a deep personal interest in the subject, perfect fluency in both languages, and an unusual empathy with the thoughts of the original author.

The book seems also to have been written at just the right time. Although research continues fairly actively in this field, the general theoretical picture appears, with one major exception, to have changed little since publication of the Russian edition in 1967. The exception, in this reviewer's opinion, is the remarkable development of the Monte Carlo "direct simulation'. method, pioneered by G. A. Bird. (See, for example, G. A. Bird (1969), *J. Fluid Mech.* **36**, Part 3, 571–576.)

F. S. SHERMAN

Two-Phase Flow Instrumentation. Published by A.S.M.E. $9·50, 101 pp. 1969.

THIS paper-bound volume contains eight papers presented at the 11th National ASME/AIChE Heat Transfer Conference in 1969. Together they form a useful review of methods of measuring the properties of two-phase, particularly liquid–vapour, flows.

Six of the eight papers were intended as reviews of particular experimental techniques. The exceptions are the papers by N. Miller and R. E. Mitchie and by G. E. Walmet and F. W. Staub. The former describes the operation of a 'universal' probe for the local measurement of void fraction and the latter specific measurements of pressure, temperature and void fraction in non-equilibrium two-phase flows. Both papers describe specific and useful extensions of techniques referred to in the review papers and are not out of place in this volume.

The review papers are concerned with Optical Techniques, Radiation Attenuation Techniques, methods of measuring the properties of liquid films and particularly wall-shear stress, Sampling Devices for phase-flow rate determination, Hot Film Anemometry and the Application of Electrical Probes to void fraction, bubble size and film thickness measurement. The authors are authorities in their subjects and have taken this opportunity to provide explanations of the principles of operation and hardware required for the various measuring techniques; applications, experimental difficulties and possible precision are also discussed.

The purpose of the volume is commendable and is well expressed in the foreword: "It is hoped that the papers contained in this volume will not only provide guidance to workers using presently available instrumentation as a tool in two-phase flow studies, but will also aid and inspire development of new and improved instruments and techniques to meet these challenges." This assembly of clearly written papers with their large and up-to-date bibliographies will undoubtedly go a long way towards the former aim and, hopefully, may provide a foundation for the latter. It is to be hoped that, to these experimental aims, might be added the need for experimental work in two-phase flow situations to be directed towards assisting the formulation and testing of prediction methods possessing considerably greater generality than many of those presently found in the literature.

J. H. WHITELAW

HOLLAND, MOORES, WATSON and WILKINSON, **Heat Transfer.** 612 pp. Heinmann Chemical Engineering Series, London (1970). £6.00 net.

THE AUTHORS are associated with the Department of Chemical Engineering at the University of Salford and their

industrial and teaching experience leads them to the conclusion that many young engineers are capable of applying only a small part of the theory provided by college and university heat transfer courses, either because the principles have not been fully understood, or because of lack of confidence in applying them. They feel that students need to solve lengthy and detailed problems in order to absorb the underlying principles in sufficient depth to allow their ready application in industry.

The book is therefore intended primarily for chemical engineering students and does not profess to provide refined design data or "short cut" design methods for the specialist industrial thermal designer or "rating engineer". It is concerned solely with the application of previously published heat transfer and fluid flow data and therefore no attempt has been made to deal with the structural aspect of equipment design and the limitations sometimes imposed by pressure, temperature, size, weight, corrosion, materials of construction, fabrication problems, vibration, noise and flow distribution problems etc. The authors emphasize that the methods of solution serve to illustrate principles and are not necessarily the best available. The book is divided into three parts plus an Appendix.

Part I, which occupies half the book, provides the detailed solutions to twenty typical heat transfer problems involving, for instance, double pipe exchangers, both plain and longitudinally finned, single phase, condensation and boiling in shell and tube exchangers, plate type exchangers, mechanical draught water cooling towers, furnaces, stirred vessels, together with heat conduction in bars and hollow sections. Each problem specifies its own nomenclature, summary of equations used, step-by-step procedure, literature references and final discussion. The numerical calculations are given in full detail either step-by-step or in tabular or grid form. Problems having analytical solutions are presented in a form which facilitates programming for solution by digital computer. Anglo-American units are used for nineteen problems, but as the authors consider that chemical engineers will need to be familiar with both S.I. and Anglo-American units for the foreseeable future, the last problem and the whole of Part II is handled in S.I. units.

Instead of including the familiar tables and graphs for fluid physical properties relevant to heat transfer and fluid flow, Part II is unusual for this type of book in that it provides previously published methods for estimating physical properties, either when no data are available, other than the chemical structural formula, or when only limited experimental data are available. At the end of this section are sample calculations and comprehensive literature references. Part III provides the heat transfer theory essential for a full understanding of Part I. The Appendix contains 19 graphs covering heat transfer and friction factors, emissivity and two phase flow data etc. for use with Part I.

Each problem in Part I is self contained and set out clearly in great detail. The correlations used at each step are clearly defined, and recognising the difficulty with units encountered by students and inexperienced designers alike, the authors provide both figures and units, side by side, at each calculation step. However, at first sight this tends to give Part I a slightly forbidding appearance and this section would have lost none of its value had all correlations been listed at the end of the book. The 42 supporting graphs and illustrations to Part I and III are clear and simple, while the treatment of vertical thermosyphon reboilers in Parts I and III is particularly good.

In later life the student may be in a position where he is responsible for specifying and ordering heat transfer equipment from specialist manufacturers who will undertake and guarantee the design. The book will enable the ex-student to specify the essential process data required by the manufacture, but its "balance" would be improved if a separate section dealing with some of the other factors affecting design, as mentioned above, had been included. This could have been achieved by condensing Part II, for although the reviewer is pleased to note the attention paid to physical properties, it would appear unnecessary to provide many sample calculations. The book contains no photographs and the inclusion of some, together with more sectional diagrams of heat transfer equipment would have been beneficial. It is not apparent why the authors provide calculations first and theory last.

This book has been written specifically for the chemical engineering student by authors who are in a position to fully understand their needs. It will also benefit the newcomer to heat transfer equipment design and both should learn much from the authors' clarity of definition, presentation and attention to detail.

E. A. D. SAUNDERS