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BOOK REVIEWS

Annual Review of Fluid Mechanics, Volume 2. 1970. Annual Reviews, Inc. $10, 461 pp.

THIS second volume of the review is as interesting and as brilliantly written as the first one. In the preface of the book the editors mention the remark of a friendly critic, that it might be difficult to maintain the standard of the first volume. The second volume proves that critic wrong but his question remains unanswered for the future. Able colleagues had volunteered to write the requested reviews without remuneration instead of doing their own research as was pointed out in the preface. I wonder whether one should not seek funds in order to remunerate the reviewers as generously as one can, since this way of reviewing seems to be one possibility—if not the only one—to cope with the rapidly growing amount of scientific results. This new series of reviews offers a very powerful tool to analyse and condense new results and see older ones in a new light; it deserves all possible support it can get, since it has become almost impossible to read all papers being published in the various subjects and, at the same time, elaborate one's own ideas.

The second volume of the review series contains 15 articles; the titles and authors are listed below.

1. The Development of Boundary-Layer Theory in the USSR by L. G. Loitsianskii
2. Critique of Numerical Modeling of Fluid-Mechanics Phenomena by H. W. Emmons
3. The Anology between Rotating and Stratified Fluids by G. Veronis
4. Applications of Slender-body Theory in Ship Hydrodynamics by J. N. Newman
5. The Turbulent Boundary Layer by L. S. G. Kovasnay
6. Nonlinear Wave Propagation in Fluids by W. Lick
7. Rheology of Two-Phase Systems by H. Brenner
8. Flow in Porous Media by J. R. Philip
9. Tides by M. Hendershott and W. Munk
10. The Atmospheric Boundary Layer by A. S. Monin
11. Models for Weather Prediction by N. A. Phillips
12. Boundary Layers in Ocean Circulation Models by A. R. Robinson
13. Solar-Wind Past Objects in the Solar System by J. R. Spreiter and A. Y. Alksne
14. Vibrational Relaxation in Gasdynamic Flows by J. W. Rich and C. E. Treanor
15. Dynamics of Dusty Gases by F. E. Marble

A very wide variety of topics is covered and the table of contents by itself demonstrates quite impressively how the basic ideas of fluid mechanics have penetrated into other fields and how concepts of analysis devised for studying a particular problem in aerodynamics have proven to be much more general as could be expected at the outset of the work. For this reason the series has a good chance of becoming an indispensable guideline for teaching advanced fluid mechanics.

In the first article it is interesting to follow the stepping stones in the development of boundary-layer theory in USSR described by such a distinguished writer as L. G. Loitsianskii. In passing, the reader is reminded of the fiftieth anniversary of von Kármán's integral solution of the boundary-layer equations. The second author then points to some new results obtained by numerical techniques. He recognizes that numerical techniques are being developed by three different groups: by those primarily interested in numerical techniques, those primarily interested in fluid mechanics and by those primarily interested in getting an answer to some specific practical problem. These group properties, of course, may in some cases be present at the same time. In his conclusions he summarizes the state of the art (in the true sense of the word) and suggests aimed experiments in order to test the validity of new numerical results. In the third article, various mathematical models are used to demonstrate the analogy of the two types of flows mentioned in the title. The general considerations are supplemented by specific examples. J. N. Newman then gives a very clear description of the slender-body theory to the determination of flow fields about ships. A number of problems, the corresponding differential equations with boundary conditions along with a number of references are given in tabulated form; several solutions are discussed in detail. L. S. G. Kovasnay introduces the reader to the latest findings in the field of turbulent boundary layers. In his article he mentions some results of the Stanford Conference on Computation of Turbulent Boundary Layers 1968. Some of the sociological aspects of that conference are as interesting as some of the scientific results and seem to support my introductory statements: Kovasnay noted that the proponents of different prediction methods could no longer ignore each other completely because of a direct comparison prepared for the conference. A good continuous review system, perhaps, might help to build bridges and stimulate exchange of information.

Lick's exposé on nonlinear wave propagation, in which he explains the various types of waves and the solutions of the associated differential equations, is followed by H. Brenner's theoretical article on rheology of two-phase systems, Philip's also theoretical but more descriptive article on flows in porous media and M. Hendershott's and W. Munk's illustrative article on tidal waves. Then, A. S. Monin shows how the turbulent structure of the lower part of the atmosphere can be analysed in terms of boundary-layer concepts; modern numerical techniques of weather prediction are described in the next article with an interesting historical review. A. R. Robinson introduces the reader to the complicated structure of oceanic boundary layers. Tables containing the various scale factors are used to classify the different layers; the following article projects the reader

into deep space and familiarizes him with the lunar wake and the shock wave trailing the moon among other extra-terrestrial flow field characteristics. The last two articles are devoted to relaxation problems in gasdynamics and dynamics of dusty gases, respectively. It remains only to mention that all articles are supplemented by extensive lists of literature which enable the reader with deeper interest to learn more about the subject if he wishes to do so. No doubt, this book will be a success.

EGON KRAUSE

H. BRAUER. **Grundlagen der Einphasen- und Mehrphasenströmungen** (Fundamentals of Single-Phase and Multi-Phase Flow). Edited by H. MOHLER, O. FUCHS, H. KRAUSSOLD and K. DIALER in the series *Fundamentals of Chemical Engineering. The Technology of the Chemical and Related Industries*. Published by Sauerlaender, Aarau and Frankfurt/M. (1971). 955 p., 520 pict. and numerous Tables. Price DM 98.—, sFr. 110. –.

IN THE chemical technology multi-phase flows are of considerably greater importance than single-phase flow. Students of chemical engineering, in spite of this, are chiefly instructed in the fundamentals of single-phase flow and only very sparsely about multi-phase flow. The engineer in chemical practice is usually not sufficiently versed in handling problems of multi-phase flow since, especially in German technical literature, no comprehensive reference book for this field was available. The book by H. Brauer was planned to fill this gap and to offer a comprehensive survey of the phenomena and current research work in multi-phase flow. Of course the flow of a single phase also had to be treated for this purpose; this was done, however, only to the extent necessary for the comprehension of the multi-phase phenomena. In conjunction with single-phase flow, the book deals with the flow in tubes, in ducts, through a bank of tubes, the flow of non-Newtonian liquids in tubes and ducts. The dimensionless parameters are derived and their significance is discussed. The treatment of multi-phase flow covers the motion of solid particles, the development and motion of bubbles and droplets, the motion of clouds of particles, the flow correlations for cases of stationary and moving particle masses, the fluidized bed, the pneumatic and hydraulic transport of granular solids, the rheology of grains, filtration and separation, gas- and hydrocyclones, the flow of falling liquid films, gas–liquid flow in tubes, in layers of packing material, in distillation columns and bubble columns and, finally, the stirring of Newtonian and non-Newtonian liquids. Furthermore, numerous supplementary cases are treated in every chapter. This long list of topics and a study of the book shows that we have here something like an encyclopedia for multi-phase flow. Clearly the book contains far more about applications, calculation methods, special problems and design features than is to be expected from the modest word "Fundamentals" chosen for the title. Nearly 1000 references, listed at the end of every chapter, render a view of the literature dealing with multi-phase flow. One notices, however, that most of the references originate from the year 1955 to 1965, whereas the most recent research work is sparsely cited.

The book avoids the full complexity in the mathematical treatment of single and multi-phase flow. The essential aim of this book is to offer a calculation reference for the engineer in industrial practice and to make the student of chemical engineering familiar with the physical fundamentals of this field. Great emphasis is therefore given to the description with dimensionless parameters. The mathematical treatment of two-phase flow, however, as it has been attempted by various authors for the investigation of gas–liquid flows, is not discussed. These mathematical descriptions, which are usually based on simple, yet quite convincing models, have been adopted with success for various stability problems. It is to be regretted that this is missing in such a comprehensive work about multi-phase flow. One also misses a discussion of the problem of heat transfer in two-phase flow which is of particular interest in the technology of nuclear reactors. Obviously the authors wish was primarily to deal with those cases of multi-phase flow that are important in the chemical industry.

Apart from this, however, the precise and always clear presentation of the fundamentals throughout the treatment of the subject deserves particular mention. The book is a valuable calculation reference for the chemical engineer and offers much stimulation for the scientist. The authors aim, to make the chemical engineer familiar with the field of multi-phase flow, is doubtlessly achieved. The book thus fills a gap which had become more and more apparent in recent years.

K. STEPHAN

D. G. SKINNER. **The Fluidised Combustion of Coal.** Mills & Boon Ltd. £1.50. 58 pp.

THE COMBUSTION of coal—or other fuels—in a fluid bed of inert particles enables the high rates both of reaction and heat transfer that occur in fluid beds to be used to give a compact, high intensity but relatively low temperature combustion appliance. Dr. Skinner in his short Monograph, has summarised most clearly the work to develop this combustion system mainly carried out as a collaborative effort by the National Coal Board, BCURA and the Central Electricity Generating Board but including valuable work elsewhere, particularly in the States. Starting from small, tentative beginnings in the early 1960's, work on the development increased till, by the end of the decade, one can claim that the main technical problems remaining to be solved to develop the process to commercial use are essentially of an engineering nature. The evidence for this is clearly given in this account of the research carried out and the findings arrived at.

The book ends just where many readers will no doubt find it begins to get most absorbing: where the fruits of the research in terms of actual plant designs are beginning to emerge. Many readers would also no doubt like to have learnt more about the operation of fluid beds under pressure and the interesting prospects this opens up in terms of combined-cycle power generation. However, we have not heard the last of fluid-bed combustion and this information will no doubt be published in time.

This monograph is one of a series covering a diverse selection of chemical engineering topics. Several besides of coal, illustrating that the science of the use of solid fuel is still a lively and forward-looking research field.

G. G. THURLOW