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REVIEWS

Combustion Aerodynamics. By J. M. Beér and N. A. Chigier. Applied Science Publishers Ltd, 1972. 264 pp. £7.00.

For the readers of the *Journal of Fluid Mechanics*, perhaps the most useful feature of this book is its title, which reminds them of the strong influence of aerodynamic processes on combustion phenomena, and of the fact that the aerodynamics of combustion has peculiarities enough for it to be regarded as a distinct branch of fluid mechanics.

Some of the interactions of fluid mechanics with chemical processes are of course straightforward. The exothermic combustion reactions provoke density changes and so cause a redistribution of the flow field; the rate of reaction is influenced, and often controlled, by the interdiffusion of fuel and oxygen in boundary layers; and the burning of a cloud of carbon particles in an air stream is subject to the usual laws of suspended-particle dynamics.

The influence of turbulence on chemical reaction, and the reverse influence if it exists, are interactions which deserve rather greater study. When the fuel and the oxygen are not pre-mixed, and the kinetic processes are too fast to exert significant resistance to the reaction, the rate of heat release is governed by the rate of dissipation of the small-scale fluctuations in concentration. This fact can perhaps be used by turbulence researches as the basis of a method of measuring dissipation rates, for the overall rate of reaction is fairly easy to measure in many circumstances.

When the fuel and the air *are* pre-mixed, the turbulent dissipation processes appear often still to control the reaction rate; but there is some evidence that it is the breakup of the larger eddies that is of most influence. A convincing model of the process is lacking at the present time.

The book under review mentions the above topics only obliquely, and by reference to the older literature. Its chapter headings are 'Introduction', 'Separated flows', 'Flame stabilization', 'Analysis-prediction methods', 'Swirling flows', 'Droplets and sprays', 'Modelling of combustion systems' and 'Measurements in flames'. Perhaps these headings were written down hastily at the beginning, and then adhered to because two authors were involved; but they have not assisted the orderly development of the subject either from fundamentals towards particular phenomena, or from practical problems towards methods of solving them.

Readers of *J.F.M.* will probably not admire the authors' style; and they will find much to criticize in their presentation of fluid-mechanical phenomena. For example, jets are handled under the 'Separated flows' heading. However, those who look at some of the cited literature, and then go on to more modern developments of the subject-matter, may well find much to interest them. Clearly, combustion specialists still need to know more fluid mechanics.

D. B. Spalding

Mécanique des Fluides. Volume III. By E. A. Brun, A. Martinot-Lagarde and J. Mathieu. Dunod, 1970. 396 pp. 84F.

This is the third volume of a multi-volume text-book, the first two volumes, issued in 1968, having been reviewed in the *Journal of Fluid Mechanics* (**37**, 1969, 414). It may be useful to recall that the book is intended for students of the 'Facultés des Sciences' following a third course in fluid mechanics and also for those academically trained engineers who want to refresh their knowledge of the basic principles of fluid flow.

Contrary to what was originally planned, the present volume contains only two parts instead of three. The first part (part 6 of the whole text-book) is entitled "Examples of unsteady flow phenomena" and the second part is entitled "Boundary layers and viscous flows". It is stated in the preface to this volume that the third part, dealing with supersonic flows, will be published as a separate monograph. The presentation of the subject-matter is similar to that in the first two volumes. Starting with a simple treatment of a subject, the reader is then guided in a gradual way to the study of more complicated aspects and a more rigorous and general treatment of the subject, though the ultimate level is still not very advanced. Because the general presentation is very clear, this volume will be welcomed by those who have to study fluid mechanics without an instructor.

The first part (90 pages) considers in three chapters: one-dimensional unsteady flow phenomena such as the oscillations of a liquid in a U-shaped tube, the propagation of weak disturbances, the water hammer, etc. There are here a few subjects with whose treatment this reviewer does not feel very happy. The derivation of the expression for the periodicity of an oscillating column of inviscid liquid in a U-tube is done in a more complicated way, through the consideration of kinetic energy and work done against gravity, than he considers necessary. If the energy approach is used, the well-known rule in mechanics of the constancy of the sum of potential and kinetic energy could be used to arrive in a more direct way at the result required. From an instructional point of view a better approach still might have been to consider a force balance, leading to a second-order differential equation for vibration without damping. When considering the propagation velocity of weak waves in a fluid the authors assume a barotropic fluid. Restriction has been made to gases only, since the authors state that a liquid has constant density. This statement may well confuse the student, because a logical conclusion would be that propagation in a liquid of waves with finite velocity is impossible. A welcome chapter is the second one, on the transmission of information by pneumatic or hydraulic methods, posed as an introduction to fluidics. The third chapter considers in a conventional way gravity waves of small amplitude on a free surface.

The second, and main, part (300 pages) of the book contains nine chapters, of which six are devoted to boundary layers, laminar as well as turbulent, with or without heat and mass transport. This second part is really representative of the step-wise way of introducing the student to boundary-layer theories.

Starting from integral relations for the mass balance and momentum balance, general relations are derived for the friction factor, the displacement and momentum-loss thickness. Incidentally, the reviewer notes that names commonly associated with certain equations or quantities are not mentioned at all, e.g. the von Kármán integral momentum-balance equation and the shape parameter of Von Doehnhoff and Tetervin. These general relations still contain numerical constants which have either to be determined empirically, or theoretically when the velocity distribution is known or assumed. For the laminar boundary layer a third-order polynomial is first taken for the velocity distribution, and only in a later section Pohlhausen's fourth-order polynomial. No explanation is given for the choice of the two possibilities in either case. The wider applicability of Pohlhausen's method to non-constant-pressure boundary layers is not mentioned. The authors assume the power-law velocity distribution for the turbulent boundary layer and also, as in the treatment of turbulent pipe flow given in volume II, the logarithmic mean-velocity distribution. The intermittent nature of a turbulent boundary layer is hardly considered. The transport of heat and mass, including the effect of molecular diffusion in the case of turbulent flow, is given in a similar way to that for momentum. Just like the mathematics employed, the physical aspects are kept rather simple. For instance, only the differential equation leading to the Blasius solution for the laminar boundary layer is considered, and its solution shown in a graph. When mass transfer is considered, the phenomenon of thermo-diffusion is only briefly mentioned. Confusing to the student may be the statement that when the relation between stresses and velocity gradients is linear the flow is laminar, otherwise it is turbulent. Another example to illustrate the author's attitude of not going into the basic nature of a phenomenon is the plane case of a rotating cylinder in a viscous fluid in an infinite domain. In the same page it is demonstrated that work is done by the viscous shear stresses, but that the sum of static pressure and kinetic energy remains conserved. The fact that for an irrotational flow this is correct only because the work done by the viscous stresses is dissipated locally is not dealt with. The last two chapters, dealing respectively with aerodynamic flow resistance of bodies and with aerofoils, are mainly of a descriptive nature.

The remarks made above may sound a bit negative. If so, this reviewer wants to make clear that this is by no means his intention, but that the remarks have been made only to illustrate the style of presentation of the subject matter. For, as an introduction to fluid mechanics and for self-study, this volume may be seriously considered.

J. O. HINZE

Regional Hydrology Fundamentals. By R. A. DEJU. Gordon & Breach, 1971. 204 pp. £8.50 or $19.50.

According to the publisher's flyleaf "The task of regional hydrology – the subject of the book – is the consideration of the broad problems of achieving the most effective use of water from an entire basin... The book includes all the material that is fundamental to the solution of such regional problems." Unfortunately, it does not. Surface water hydrology is presented at an unusually elementary level. Quantitative methods of hydrologic analysis, such as rainfall-runoff relationships, unit hydrographs, and storm frequency forecasting, are hardly mentioned. Existing methods for regional hydrologic study, such as operations research techniques for optimizing the size of reservoirs, and environmental isotope tracer techniques for large-scale tracing of water movement, are not discussed. What quantitative material exists is often inadequate; for instance, the discussion of measurement of river flow by radio-isotopes does not mention the length required for initial mixing. Instead, the book abounds in useless generalities, most of them unsupported and some of them incorrect.

In contrast, the section on sub-surface flow is presented at an advanced level, with detailed mathematical derivations of the equations of ground water flow. The section on well hydraulics occupies nearly one-third of the book. Some readers might wish to purchase the book solely for this section, which does seem to be well presented, although I did not notice any material which is not covered in several previous books on ground water and well hydraulics.

The closing section on "Regional geochemistry of water" returns to an elementary level. A typical statement is that "The cleanest water should be kept for human consumption, while recleaned water is supplied to industry and used for irrigation." No definition of 'clean' is supplied. There is a useful listing of the chemical properties of water, but nothing not found in the usual texts on water chemistry and treatment. As with the remainder of the book, the term 'regional' connotes nothing not found in virtually all other treatments of the same material.

H. B. Fischer