REVIEWS

Open Channel Flow. By F. M. HENDERSON. Macmillan, 1966. 522 pp. $14.95.

No book can be all things to all readers, nor can either an author or a reviewer judge wholly objectively what a book is or should be. Professor Henderson has chosen to present, under a title already used generically for both lengthy tomes and single chapters, an undergraduate and postgraduate text-book of inclusive topical coverage, which to the present writer seems to go well beyond classroom requirements yet at the same time to lack certain requisites of good pedagogy.

The broad scope of the book can be seen at once from the chapter headings: (1) Basic concepts of fluid flow; (2) The energy principle in open channel flow; (3) The momentum principle in open channel flow; (4) Flow resistance; (5) Flow resistance—non-uniform flow computations; (6) Channel controls; (7) Channel transitions; (8) Unsteady flow; (9) Flood routing; (10) Sediment transport; and (11) Similitude and models. The introductory chapter reviews the one-dimensional principles of continuity, momentum, energy, resistance and similarity. The energy chapter applies the Bernoulli relationship for constant total head to flow at transitions and discusses the role of the critical depth; this is followed by an appendix on mathematical aids. Application of the momentum principle is restricted to the hydraulic jump and surges, and this chapter also concludes with an appendix on mathematical aids.

In the first resistance chapter the Colebrook and Manning formulas are applied to non-uniform steady flow in prismatic channels with local changes in section or alignment; in the second, methods of computing profile and delivery functions are presented for both artificial and natural channels, including use of the high-speed computer. The sixth chapter deals with problems of overflow, underflow, metering, and energy dissipation. In the seventh, changes in section and alignment are treated, particularly for supercritical flow, with attention to bends, piers, culverts, and lateral inflow and outflow. Next the equations of unsteady motion, including the method of characteristics, are applied to surges, the dam-break phenomenon, shallow-water and deep-water waves, wave modification, and roll waves. Chapter nine covers the technique of storage routing, speed and attenuation of flood waves and effects of channel irregularity, routing by characteristics, and routing curves. Chapter ten includes matters of bed formation, the beginning of sediment movement, suspended load, bed load and entrainment, stable channels, and natural rivers. The final chapter reviews similarity parameters and discusses the planning and operation of fixed-bed, movable-bed, and unsteady-flow models.

The author displays from start to finish a perceptive familiarity with his subject, which could not have been gained solely in the lecture hall, laboratory, or field. Details as well as primary features are expertly treated, and the many examples and problems are imaginative and stimulating. The illustrations (including photographs presumably taken by the author) are numerous and clear, evidence of carelessness in minor yet significant details on the part of

either draftsman or author being relatively infrequent. On the other hand, the approach is almost exclusively one-dimensional; principles are more likely to be taken for granted than derived (except, perhaps, for the 'complete theory' of unsteady flow); and emphasis is generally placed on the engineering application of existing knowledge rather than the scholarly examination of what is still imperfectly understood that one might expect of at least a postgraduate treatment.

As is probably true of all text-books, this one does its share in repeating a few imperfect references and letting a few additional sources pass into oblivion, despite the author's obvious effort to include an extensive and useful bibliography. The literature cited is preponderantly American, though English, French and German titles are by no means neglected. Other literatures—or even a just balance among these four—would perhaps add little to the true effectiveness of the book. Yet the reviewer cannot help reflecting, albeit irrelevantly, on the fact that a west-European or east-European text in the same field, based by custom primarily on continental or Soviet literature, would include relatively few of the references given herein.

Be that as it may, it cannot be denied that the author has produced a book that is likely to prove very popular and usable among English-speaking countries during quite a few years to come, whether as a text or design-office manual. For instructional purposes, nevertheless, it should be preceded by a good foundation in the mechanics of fluids; for reference purposes, the admitted predilection of the author for things American—however gratifying it may be to the reviewer—should be countered by an open mind on the part of the reader.

HUNTER ROUSE

Mechanical Principles of Polymer Melt Processing. By J. R. A. PEARSON. Pergamon Press, 1966. 148 pp. 35*s*.

The industrial processes of calendering and extruding thermoplastics involve the flow of molten polymers under conditions that are extremely difficult to cope with as an exercise in continuum mechanics. In his monograph, Dr Pearson portrays very clearly the enormous magnitude of the theoretical problem of accounting for the general success of standard processes and explaining the conditions under which they are found to fail.

The reference on the first page to 'theological' equations of state proves, unfortunately, to be a misprint, for the equations the author has to offer in an early chapter on flow behaviour of thermoplastic melts are decidedly man-made and very far from perfect. Formulae are included for the stresses and flow characteristics of some of the better-known idealized elastico-viscous liquids in idealized viscometric situations, but with more emphasis than usual on complications such as inlet and outlet conditions and temperature effects, all vitally important to those whose business is extrusion. An account is given of some unstable flows between rotating cylinders, and between rotating cone and plate, and a tentative explanation is included of the break-down of rectilinear flow

through a capillary that can give rise to either slight or marked irregularity in the extruded melt. Some discussion of the lubrication approximation for flows in narrow channels and of wall-slip effects is included.

An account of continuous calendering and extrusion processes follows. The flow of a molten polymer through the 'nip' between a pair of calendering rolls will in general involve rapid shearing and mixing, with enough heat created by energy dissipation to cause a significant rise in temperature. An assumption of isothermal conditions or temperature-independent properties would be totally out of place. Flow through a single-screw extruder, even without the complications of 'feed-controlled' or 'melt-controlled' running from a hopper of powdered solid and external heating, leads to the consideration of a forced secondary flow superposed on the longitudal flow down a channel of rectangular section. Some progress can be made with the analysis if viscosity is taken to be proportional to a power of the rate of shear, with a coefficient of proportionality varying exponentially with temperature. The reader is introduced successively to the flow in a die, basic die design, and the combined extruder die system. Melt spinning of fibres, involving an extension zone in the neighbourhood of the spinneret, a hot-drawing zone, followed by a cool-drawing zone, is discussed to the point when the filament ceases to be liquid. Film casting and film blowing, somewhat analogous to fibre spinning but in two dimensions, are treated briefly, as is finally the complication of a cyclic process designed to produce a succession of moulded articles instead of a continuous extrudate.

There are throughout clear diagrams and explanations, and at the end a useful collection of references and an index.

For the applied mathematician concerned with rheological theory, this will be a stimulating book. It effectively poses some difficult problems, currently of great importance in industry, to which non-Newtonian fluid mechanics might well devote more attention. It will serve particularly to focus attention on the rather wide gap that exists between present theory and the practical achievements of technology in polymer-melt processing. Engineers who read it may be encouraged to look with less impatience on the slow progress of their theoretical colleagues towards a treatment of real materials in real situations.

J. G. Oldroyd