

REVIEWS

Evolution of Physical Oceanography. Edited by B. A. WARREN AND C. WUNSCH.
MIT Press, 1981. 623 pp. £23.25.

This is a really excellent volume, and a splendid tribute to Henry Stommel on his 60th birthday. I found much of it compelling reading because it is a nice blend of a historical perspective and a review of current status. It is no mere collection of papers, because the editors carefully organized it to be a comprehensive survey of the field with the additional aim 'to trace the development of the subject since the time when Stommel entered the field'. One of the editors, B.W., is perhaps a little over-enthusiastic in this regard when he begins his discussion of the 'Deep Circulation of the World Ocean' with extensive quotes of the temperature measurements of the slave-trader captain Henry Ellis in 1751 and Count Rumford's ideas about the thermally driven circulation! His chapter is, in fact, a much needed, comprehensive and readable account of this subject, which should be given much more attention than it has in the past decade. Let us hope that his penultimate sentence, 'They point, rather, to several quite fundamental aspects of the deep ocean circulation that seem, even after 200 years of study, to be still only dimly understood', will seem out of date in another decade or two.

The second chapter, by Worthington, on results of a water-mass census may seem extremely dull to *JFM* readers, but it does raise some interesting questions. For instance, why should there be more water in the very narrow temperature-salinity range of 1.1–1.2 °C and 34.68–34.69 ‰, than there is in *all* the continental ice-caps or in *all* the ocean water warmer than 19 °C? To what extent is the structure we see a result of past conditions?

The book is divided into four parts: general circulation, physical processes, techniques and 'ocean and atmosphere'. Another chapter in the first part that I found especially interesting is by Beardsley and Boicourt about continental shelf circulation. They, too, give a splendid pre-Stommel survey featuring such early oceanographers as F. L. Ekman, the father of the spiral Ekman, and lead on to modern evidence (for the Middle Atlantic Bight) about local wind driving and driving by pressure gradients from without.

Fofonoff brings us up to date with the very considerable increase in knowledge about the Gulf-Stream system since the first publication of Stommel's book in 1965. Satellite pictures now give an excellent impression of the behaviour of eddies, meanders, and rings, and a great many field measurements and numerical model experiments have added to our knowledge. Despite this, there are still a multitude of open questions such as the reason for the separation of the Gulf Stream at Cape Hatteras, or for the radical change in behaviour beyond the Grand Banks. Other articles in Part 1, all of which are by acknowledged experts and enhance the volume, are on the mid-depth circulation (Reid), dynamics (Veronis) and equatorial currents (Leetmaa, McCreary & Moore).

The contribution from the other editor, C.W., on low-frequency variability (which is placed in Part 2 on physical processes) is recommended reading for the *JFM* clientele because discoveries in this area in the last twenty years have caused us to

look at the ocean in quite a different way. In particular, the ocean is now regarded as having a rather turbulent character with energy-containing eddies measuring hundreds of kilometres in diameter. Although the study of the 'mesoscale is very much in its infancy', the author says, 'one can draw a few qualitative conclusions that may survive future observational programs'. 'The intense recirculations', 'the underlying eddy field and the formation and decay of Gulf Stream rings' 'suggest an intimate relation between the generation of the eddy field, the maintenance of the eastward going jet, and the transition of the jet into the comparatively quiescent interior in a complex dynamic linkage that we can only vaguely understand. One would guess that the next 10 years will find many of the keys to these puzzles.'

The part on 'physical processes' has chapters on small-scale mixing processes (Turner), and internal waves and small-scale processes (Munk), which show how rich in structure the ocean is, and how much we have learnt about it in the last ten years. Again the authors point out the need to develop a unified picture of the way these processes work together in the ocean, and how the large- and small-scale processes affect each other. Other chapters in this part of the volume are on long waves and ocean tides (Hendershott), biological oceanography (Steele) and the amplitude of convection (Malkus).

Part 3 contains three chapters on ocean instruments and experimental design (Baker), geochemical tracers (Broecker) and laboratory models (Faller). *JFM* readers will find the last of these particularly interesting as it covers a wide range of subjects from ocean circulation to Langmuir cells, and includes an interesting account of some experiments on a rotating table made by C. A. Bjerknes in 1902 to examine the angle currents made with a stream of air blown over a cylinder of water.

There are only two chapters in Part 4, but they both make very good reading. Charnock's chapter on air-sea interaction discusses the boundary layers adjacent to the sea-surface and it is interesting to see what he has to say about 'Charnock's relation' in the light of the latest measurements. The last chapter is extremely valuable to have, as Charney and Flierl discuss oceanic analogues to large-scale atmospheric motions. It is sad to think that this is one of Charney's last papers, but great to have the views of a man who has contributed so much to meteorology and oceanography.

Of course, the whole purpose of the book is to honour Henry Stommel and it is nice to have five tributes to him from Arons, Veronis, Montgomery, Deacon and Fuglister varying from 'a theoretical model' to his 'scientific work' and 'on the light side'. These articles convey much of his humour, enthusiasm and ability to inspire others. The book is an excellent tribute and a very worthwhile contribution to the subject.

A. E. GILL

SHORTER NOTICES

Fluidisation. Edited by J. R. GRACE and J. M. MATSEN. Plenum Press, 1980.

605 pp. \$69.50.

The technique of bringing solid and fluid materials into close contact for long periods by means of a fluidised bed of solid particles has been developed intensively during the past 50 years, and is widely used in process industries. The rate of transfer of heat or mass between the fluid and the particles in a fluidised bed is high and con-

trollable, an almost uniquely favourable combination for a chemical engineer. But the ideal situation in which the bed remains statistically homogeneous and the overall transfer rate is maximised is difficult to attain in practice, especially in gas fluidised beds. Instabilities, bubbles, bed spouting, particle agglomeration and a host of other complications have been observed, providing a challenge to the technologist and a source of scientific interest for those able to take a more detached view.

Big international conferences on fluidisation have been held periodically in recent years to review progress in both the technology and the underlying science, and this volume contains the papers presented at the latest in the series, held at Henniker, New Hampshire, in August 1980. Three of the papers are invited surveys, and the other 60 are contributed papers, said to have been refereed before publication. The book has been produced from camera-ready typed copy, but is complete with page headings and numbers and both author and subject indexes and is easy to read and use. For those concerned with fluidisation it provides an important record of the present state of the subject.

Flow and Transport in Porous Media. Edited by A. VERRUIJT and F. B. J.

BARENS. Balkema, 1981. 232 pp.

This volume contains the texts of 33 talks presented at a Euromech Colloquium on flow and transport in porous media held at Delft in September 1981. The pages of the book, which is well bound between hard covers, have been reproduced photographically from typed pages provided by the authors, but even so it is a remarkable achievement of the editors and publishers to produce the book before the meeting itself. (Whither it is wise for the authors to commit their talks to paper before they meet in order to discuss each other's contributions is perhaps another matter.) The range of problems considered is wide, although certain topics are prominent, viz unsteady flow, salt-water intrusion into aquifers, flow in unsaturated porous media, transport of contaminants, and hydrodynamic dispersion. Developments in the technology of flow in porous media seems at present to be outstripping those in the associated science. A few expository survey papers would perhaps have made the volume more interesting for readers.

Ecohydrodynamics. Edited by J. C. J. NIHOUL. Elsevier, 1981. 359 pp. \$58.50.

This volume, number 32 in the Elsevier oceanography series, contains the proceedings of the 12th International Liege Colloquium on Ocean Hydrodynamics, and is devoted to hydrodynamical problems on length scales of the order of hundreds of kilometers and time scales of the order of months, which have a bearing on oceanic biological systems. Nihoul defines the scope of the volume with his introductory article 'Marine hydrodynamics at ecological scales' in which he gives some interesting examples. Why, for example, are the spawning grounds of plaice in the North Sea so well defined and so stable from one year to the next? Presumably a result of favourable conditions of temperature, salinity and transported nutrients, all controlled by hydrodynamic currents. In effect, the hydrodynamic processes impose a strong constraint on the ecological processes. The volume contains sixteen articles, some less clearly ecological than others, but with this idea of hydrodynamic constraint as the dominant theme. Reproduction is from camera-ready copy, and the quality is variable.

Fluid Mechanics in Energy Conversion. Edited by JOHN DAVID BUCKMASTER. SIAM, Philadelphia, 1980. 315 pp. \$28.50.

This is the proceedings of a conference on the interaction of fluid mechanics and energy-producing processes, with a particular focus on energy from the ocean and the ground, and on nuclear-reactor cooling and on combustion. The book is reproduced from 15 typewritten papers, but there are numerous helpful and well-drawn diagrams. The mathematical ideas are presented clearly; the editor has done a good job.

Prediction methods for turbulent flows. Edited by W. KOLLMANN. Hemisphere Publishing Corp. (a von Karman Institute Book), 1980. 486 pp.

This is a collection of lecture notes given at the von Karman Institute in 1979 by turbulence specialists from USA and Europe. The topics treated in detail are second-order modelling and turbulent flows, the different aspects of modelling methods based on correlations and spectra, direct numerical simulation of turbulence, applications of turbulence models to environmental and oceanic problems, and models based on covariances and probability density functions for turbulent flow with density variations and combustion. The book is well reproduced from (non-uniformly) typewritten notes; there are plenty of informative diagrams. I found the volume interesting and useful.

Multiphase transport, Volume 1 – Fundamentals, Reactor Safety, Applications. Edited by T. VEZIROGLU. Hemisphere Publishing Corp., 1980. 580 pp.

This is a five-volume proceedings of a symposium-workshop on multiphase flow and heat-transfer studies. The subjects covered by the volumes are:

- (1) experimental, theoretical and 'mathematical-modelling' studies of multiphase flows;
- (2) boiling, condensation, heat transfer and pressure drop;
- (3) instabilities in boiling, reactor safety calculations;
- (4) pumping, gas/particle systems, fluidized beds;
- (5) flow in porous media, experimental techniques and workshop reports.

These volumes are a good indication of who is doing what and the present state of the engineering aspects of these subjects.

Fluid Flow through Porous Macromolecular Systems. By F. W. WIEGEL. Springer, 1980. 102 pp. DM18.

The macromolecular systems referred to in the title are either an isolated macromolecule in solution or a macromolecule in a membrane. The properties of the macromolecule, such as its rotational or translational diffusivities, are calculated taking into account the flow of the suspending fluid. An isolated macromolecule is studied first by assuming it to be spherical and assuming the flow to be governed by the Brinkman equation inside the sphere (hence the word porous in the title), and the Stokes equation outside. The permeability of the coil is taken either to be uniform or to be that derived from a Gaussian-coil model. A similar approach is used to study a macromolecule in a cell membrane. The Brinkman equation is now applied inside a disk which is confined to move in a layer of fluid. The flow around the disk is solved assuming two-dimensionality. The book is an introduction to the area and the level is not advanced.

Annual Review of Fluid Mechanics. Volume 13. Edited by M. VAN DYKE, J. V. WEHAUSEN and J. L. LUMLEY. Annual Reviews Inc., 1981. 530 pp. \$17.50.

The contents of this year's volume are as follows:

- My early aerodynamic research – thoughts and memories, M. M. Munk.
- Coastal sediment processes, K. Horikawa.
- Some fluid-dynamical problems in galaxies, C. C. Lin & W. W. Roberts, Jr.
- Debris flow, T. Takahashi.
- Existence theorems for the equations of motion of a compressible viscous fluid, V. A. Solonnikov & A. V. Kazhikhov.
- Turbulence in and above plant canopies, M. R. Raupach & A. S. Thom.
- Conditional sampling in turbulence measurement, R. A. Antonia.
- Power from waver waves, D. V. Evans.
- Meniscus stability, D. H. Michael.
- Some aspects of three-dimensional laminar boundary layers, H. A. Dwyer.
- Stability of surfaces that are dissolving or being formed by convection diffusion, T. J. Hanratty.
- Progress in the modeling of planetary boundary layers, O. Zeman.
- Cavitation in fluid machinery and hydraulic structures, R. E. A. Arndt.
- The fluid dynamics of insect flight, T. Maxworthy.
- Field-flow fractionation (polarization chromatography), E. N. Lightfoot, A. S. Chiang & P. T. Noble.
- Frazil ice in rivers and oceans, S. Martin.
- Cup, propeller, vane and sonic anemometers in turbulence research, J. C. Wyngaard.
- Brownian motion of small particles suspended in liquids, W. B. Russel.
- Organized motion in turbulent flow, B. J. Cantwell.

Non-Homogeneous Media and Vibration Theory. By E. SANCHEZ-PALENCIA. Springer, 1980. 398 pp. DM41.

The two chapters in this book that address problems in fluid mechanics directly are *Flow in Porous Media* (28 pages) and *Vibrations of Mixtures of Solids and Fluids* (32 pages). The first part of the book briefly reviews the mathematical tools that are used later. These include distributions, Sobolev and Banach spaces, semigroups and Laplace transforms. The first general problem studied is that of homogenization, which is the derivation of equations that describe the behaviour, on a large length scale, of a medium that is inhomogeneous on a small length scale. Examples treated are inhomogeneous elastic, and visco-elastic, bodies, porous media and solid-fluid mixtures. A formal asymptotic analysis is used to find the 'homogenized' equation, but the solutions of these equations are considered only with respect to questions of existence and uniqueness. The later parts of the book range over a number of problems in perturbation techniques and problems in diffraction. This book, although introductory, assumes a high mathematical level from the reader.

Practical Hydraulics, 2nd Edition. By A. L. SIMON. Wiley, 1981. 403 pp. £12.95.

The author states in his preface that he aims to provide 'essential information for anyone seeking practical answers for everyday hydraulic problems. No attempt is

made to present the material in the framework of theoretical fluid mechanics.' Thus, only the first three chapters could be called straight theory, and the rest of the book introduces theoretical concepts as they are needed. For example, the difference between laminar and turbulent flow is described in the chapter on flow in pipes as part of the explanation of the form of the friction factor; the index does not even list the words *laminar* or *turbulent*. There are chapters on flow in pipes, pumps, seepage, open-channel flow, flow through hydraulic structures and flow measurements. In keeping with his aim, the author supplies the reader with large amounts of technical data, in the form of graphs or tables, in every chapter.

Shear Flow in Surface-Oriented Coordinates, 266 pp., \$40.00, DM72. By E. H. HIRSCHL and W. MORDULLA. Freidr. Vieweg & Sohn, Wiesbaden, 1981. Photographic reproduction from camera-ready copy; paperback.

This is volume 4 in a series entitled 'Notes on Numerical Fluid Mechanics'. (The earlier volumes were entitled: 1, Boundary Algorithms for Multidimensional Inviscid Hyperbolic Flows; 2, Third GAMM-Conference on Numerical Methods in Fluid Mechanics; 3, Numerical Methods for the Computation of Inviscid Transonic Flows with Shock Waves.) This latest volume deals for the most part with the numerical integration of steady three-dimensional compressible boundary-layer equations, which are expressed throughout in curvilinear coordinates tailored to the fluid boundaries. The book has a highly specialized character, and employs an esoteric notation, which will not be to everyone's taste.

SSPA-ITTC Workshop on Ship Boundary Layers 1980, Proceedings. 264 pp. Edited by L. LARSSON. Swedish Maritime Research Centre publication, Goteborg, 1981. Photographic reproduction from camera-ready copy; paperback.

This volume contains the proceedings of a workshop held in Gothenburg in June 1981, and devoted to computational methods for three-dimensional turbulent boundary layers. The workshop followed the pattern set by the 1968 Stanford Conference (Computation of Turbulent Boundary Layers) by inviting participants in advance to apply their methods to two particular test cases (involving a cargo liner hull and a tanker hull). Fifteen of these methods are described in this volume, and their relative merits are discussed in relation to the available boundary-layer measurements.