Book reviews

Turbulent Shear Flows 4 — Selected Papers from the Fourth International Symposium on Turbulent Shear Flows

Eds L. J. S. Bradbury, F. Durst, B. E. Launder, F. W. Schmidt and J. H. Whitelaw

The publication of this attractive volume of selected papers by Springer-Verlag marks the fourth of five international symposia that have been held biennually on the subject of turbulent shear flows since the first meeting at the Pennsylvania State University in April of 1977. Held at different geographical locations (but, to date, only in the US and Europe), each symposium has provided a forum for the timely and effective exchange of current information among researchers from all over the world. Subsequent to each symposium, a series of selected papers has been published that is representative of the most incisive and lasting communications presented. The present volume contains expanded, reviewed and edited versions of 27 papers that were chosen from among more than 100 presentations made at the Fourth International Symposium on Turbulent Shear Flows, held at Karlsruhe University in Germany during September of 1983.

The publication format of Turbulent Shear Flows 4 (TSF4) is the same as that established in the first volume, which seems to have served the editors well in subsequent volumes. This consists of grouping selected papers into sections, according to subject topic, whith a short but incisive introductory review article by an expert in the field preceding each section. In the present volume the sections and ratio of experimental/theoretical papers are:

- Fundamentals (2/5)
- Free Flows (6/1)
- Boundary Layers (6/1)
- Reacting Flows (2/4)

The remainder of this review comments on the contents and significance of TSF4, with special emphasis placed on the relationship of this volume to the first three symposia and their corresponding publications. Hopefully, a review that includes a chronological scientific perspective will provide some insight concerning the desirability, usefulness and expectations of future turbulent flow symposia and their attendant volumes of selected papers. To this end Table 1 has been prepared.

The table reveals a recurrence of volume section topics and major issues between 1979 and 1985. For example, 'Wall Flows', and under this heading the specific issues of 'streamline curvature', and 'mean flow unsteadiness' appear consistently. Another example is 'Turbulence Modelling', which appears in most of the section topics and threads its way through 'Fundamentals' under the issue of 'second and third moment closures'. The need for high quality target experimental data from benchmarks experiments is an issue consistently and explicitly addressed; under 'Recirculating and Complex Flows' in TSF1, 2 and 3, and under 'Wall Flows' in TSF4. (In this regard it is interesting to observe the significant relative increase of experimental papers subsequent to TSF1.) In some cases section topics, such as 'Environmental Flows' and 'Coherent Structures', have evolved into major issues within the context of other, presumably more appropriate, section topics. It is clear that within the limitations imposed by the requirements of a high quality, finite and affordable publication, the editors have consistently worked to reflect the variety and vitality of turbulent shear flow phenomena by seeking to restructure section topics and major issues as research in the field evolves.

In TSF4, the editors have emphasized the publication of experimental studies. Even though theoretical analyses and calculations are 'reported for increasingly complex flows', numerical, computational and model limitations seem to be 'leading to new interests in experiments *and in the use of calculation methods more as a means to interpolate the measured results*.' Thus, the bulk (twelve out of fourteen) of the 'Free Flows' and 'Wall Flows' papers in this volume deals with the measurement of turbulence properties in wakes and boundary layers, respectively. The structures and associated turbulence properties in these flows are issues of major concern, especially in relation to natural or imposed oscillations. The skilful use of new (liquid crystal layers) and old (smoke, hydrogen bubbles) visualization techniques, conditional sampling methodologies applied to hot-wire probes, and computerized data processing allow detailed pictures of a flow to be compared with corresponding 'pictures' of the measured field variables. It is noteworthy that the two non-experimental papers in these two sections both deal with the numerical simulation of turbulent flows subject to periodic disturbances. They represent major computational attempts to account for the space- and time-variation of external conditions on the phase shifts and amplitude modulations exhibited by the flows as a result of the wave number dependence of turbulent interactions.

The sections on 'Fundamentals' and 'Reacting Flows' in TSF4 have in common a predominantly theoretical weighting of selected papers. Table 1 lists the major issues addressed. One notes that the section topic 'Fundamentals' appears to have evolved into a 'catch-all' for issues that appeared in earlier volumes under the section topics 'New Directions in Modelling', 'Turbulence Modelling', 'Coherent Structures' and 'Environmental Flows'. In the present volume this has resulted in an interesting but rather disjointed collection of papers, without the underlying theme that characterizes the other sections. With respect to the turbulence closure papers, one might ask if the comment made by Gibson in the context of boundary layer flows (p. 219) applies, namely 'Work in this field seems now to have settled down to valuable but unspectacular improvements in detail to the closure methods devised in the early 1970's. A basic need is for reliable experimental data to guide development ...'. With respect to Gibson's two points it is encouraging to see: Janicka and Kollmann proposing a one-point model that describes intermittency and zone-conditioned mean and turbulence quantities; Dekeyser and Launder comparing their measurements and predictions of triple moments of velocity and temperature in a heated turbulent jet.

While the issue of scalar transport has been addressed in earlier volumes, TSF4 contains the first selection of papers explicitly dealing with 'Reacting Flows'. Two papers deal with the effects of chemical reaction and the associated heat release on turbulent transport and, in particular, the gradient hypothesis. The remaining four papers address various aspects of the effects of the turbulence on chemical reaction rates. Here one notes that, in spite of the advanced laser-based optical techniques available, modelling efforts are hampered by the lack of sufficiently detailed experimental data.

Together with the earlier volumes on Turbulent Flow Symposia, TSF4 provides a good indication of current knowledge on turbulent flows. The flexible subject framework about which both the symposia and their respective volumes have been organized has served to maintain a timely awareness of developments in the field. However, this review has uncovered two signs that portend the vitality and usefulness of

Table 1 Symposium volume topics and some major issues addressed. Ratio of experimental to theoretical (or numerical) papers shown parenthetically. Years correspond to symposium meeting and publication of symposium volume respectively

Volume Section Topic	TSF1: 1977/79 (11/16)	TSF2: 1979/80 (14/13)	TSF3: 1981/82 (13/11)	TSF4: 1983/85 (16/11)
New directions in modelling	Direction numerical simulations: large eddy calculations (LES) and subgrid modelling; vortex methods.			
Turbulence modelling	Developments in second moment closures and consideration of buoyancy effects.	Development of more general second moment and probability density function (pdf) closures; testing of closure hypotheses.		
Fundamentals			Development and testing of second and third moment closures; direct numerical simulation; radiative cooling; use of massweighted averaging in modelling.	Geophysical flows; intermittency; advances in: second and third moment closures, pdf and conditional averaging approaches, subgrid LES modelling.
Environmental flows		Development and testing of higher order closures to predict geophysical flows.		
Coherent structures		Experimental studies of flows with organized large-scale structures.		
Recirculating and complex flows	Provision of 'target' experimental data from benchmark experiments; turbulence model applications and testing; problems related to numerical calculation accuracy.			
Free flows	Intermittency; conditional averaging; mean flow unsteadiness; turbulence model testing.			Wake flows: 2 and 3-D structure; effects of streamline curvature, adverse pressure gradients and induced asymmetries.
Wall flows	Streamline curvature; mean flow unsteadiness; turbulence model developments and testing.	Streamline curvature and buoyancy; diffusion of passive scalars; intermittency; wall blowing.	Streamline curvature; diffusion of passive scalars; mean flow unsteadiness; coherent structures in modelling.	'Target' experimental data; development or improvement of experimental techniques; measurement, modelling and prediction of unsteady flows.
Flows with scalar transport			Testing of gradient hypothesis; modelling using pdf and joint pdf approaches; influence of coherent structures.	
Flows with chemical reaction				Influence of reaction and heat release on turbulent transport; influence of turbulence on reaction; development or improvement of experimental techniques; developments in reaction rate closures; evaluation of scalar dissipation by direct numerical simulation.

future symposia (and their volumes) which should not be ignored.

First and foremost is the observation that most *if not all* of the research material presented at the symposia and subsequently selected for inclusion in volumes falls into the category of what Thomas S Kuhn calls 'normal science'; meaning research firmly based upon one or more past scientific achievements that the fluid mechanics community presently accepts as the foundation for further study. Although necessary for the organization and advancement of fundamental knowledge, in a field as complex and unresolved as turbulence, there is no place for an entrenchment in paradigms that have been found to be temporarily useful. There must be room left for major innovations, both conceptual and phenomenal.

Therefore, solely providing a forum for reflecting the state of the art in turbulence is unsatisfactory. Future symposia should include efforts to identify and select especially significant questions for in-depth discussion at the symposia and, if appropriate, for sub sequent inclusion in the corresponding volumes. For example, this reviewer believes that a 'revolution' (again in the sense of Kuhn) is imminent in fluid mechanics research methodolody and that it will come with the use of computers as tools for the *synergistic* experimental and numerical simulation of turbulent fluid mechanics phenomena. The multiprocessing and massive parallel computing characteristics of new computers makes it possible to conceive of this. The potential for very fast exchanges of large amounts of information between the experimental and numerical data bases corresponding to a given flow opens up an entirely new era of real-time, interactive, research methodology in turbulence.

The conclusion of this point is that, in the interest of maintaining the usefulness and maximizing the impact of future symposia and their volumes, more attention must be given by the symposia organizers and the volume editors to providing guidance on specific significant issues, as opposed simply to subject areas, which will lead to new concepts and paradigms in turbulence.

Second is the observation that while the symposia volumes have served as a permanent depository for new and valuable experimental and numerical data, this is by necessity limited and inconvenient to use. The editors should consider establishing a bank of critically reviewed data of permanent value to the fluid mechanics community which is readily accessible via one or more computer networks. This is, of course, much more easily suggested than accomplished in practice! Perhaps a solution lies in pooling resources with other organizations, such as AIAA, APS, ASME, etc., having similar interests and needs.

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Handbook of Hydraulic Resistance

I. E. Idelchik

This should be a very useful book for engineers designing flow circuits for laboratory or field. It deals primarily with closed conduits and the emphasis is on incompressible flows.

An introductory chapter on hydraulic principles is followed by eleven chapters on various categories of head losses. The first of these is on friction loss in uniform conduits, while the subsequent ten chapters deal with specific types of local departure from uniform flow. These cover, in order: entrance losses; orifices and abrupt enlargements or contractions; gradual changes, eg, diffusers; elbows and bends; merging and division, eg, wyes and tees; grids, screens, packings, etc; valves and seals; obstructions in the conduit, eg, rods, structural elements; exit losses; and finally, flow through specific pieces of apparatus, eg, scrubbers, cyclones.

Each of the above chapters starts with a section of text which gives explanations and recommendations. This is followed by a section of curves and charts which organize and tabulate much of the foregoing information. A list of references concludes each chapter; about two-thirds of them are from the Russian literature. The chapters provide an impressive compendium of information garnered from this material; to pick an arbitrary example from the section on elbows, at least eight configurations of segmented circular elbows alone are presented. Obviously all possible situations cannot be covered, but it is felt that the information provided, together with the principles described, may assist the user in making estimates for other cases.

Considering the amount of material included, the book is reasonably convenient to use. Reference to the text may be necessary to properly interpret some of the summary curves. The translation is generally good and the textual material flows smoothly. A few interpretations may be unfamiliar to readers at first, but not so as to hamper understanding. An example is 'stabilized' pipe flow, which apparently means fully developed uniform flow. In summary, the handbook is recommended for design engineers.

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Published price $89.95, by Hemisphere Publishing Corporation, 79 Madison Avenue, New York 10016, USA, 640 pp.

Fluid Mechanics Measurements

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A book which addresses not only the conceptual aspects of measurements in the area of fluid mechanics but also practical features of their implementation is particularly welcome. The work addressed herein does just that, and in an admirable fashion that includes a comprehensive overview of a wide range of topics.

The section on differential pressure measurements includes consideration of both mean, and most importantly, fluctuating pressure. The topics of thermal and laser anemometry are addressed in considerable detail. Methods of flow visualization include direct injection techniques, as well as more sophisticated optical arrangements involving shadowgraph, Schlieren and interferometic techniques. Moreever, there is a very substantial section on measurement of wall shear stress.

The book is by no means limited to measurement techniques in single phase, Newtonian fluids, as evidenced by substantial coverage of techniques applicable to non-Newtonian and two-phase flows. Finally, the practising engineer will benefit greatly from the section on volume flow measurements.

All in all, this reviewer found the presentation of material to be lucid and easily approachable, a tribute to both the authors and the editor. It will be useful to the spectrum of workers in this field, ranging from those concerned with basic research to engineers involved with practical design.

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Published price $55.00, by Hemisphere Publishing Corporation, 79 Madison Avenue, New York, NY 10016, USA, 630 pp.