Int. J. Heat Mass Transfer. Vol. 14, pp. 1753–1754. Pergamon Press 1971. Printed in Great Britain

BOOK REVIEWS

U. GRIGULL and E. HAHNE (Eds.), **Progress in Heat and Mass Transfer,** Vol. I (Monograph series of the International Journal of Heat and Mass Transfer) Pergamon Press, 1969. Price £12 ($32.00) viii + 471 pp.

THIS is the first volume in a series instituted by this Journal to satisfy an urgent need. This arises from the acute pressure on the Journal's space and the Editors' understandable insistence on conciseness and brevity, which forces them, reluctantly, to refuse valuable, but lengthy, manuscripts that would suffer grievously from a drastic reduction in extent. I am not sure, however, that the solution adopted by the Editors and Publishers really solves the problem. The volume contains six unquestionably valuable but specialized monographs or doctoral theses. It is, therefore, unlikely that individual designers and research workers or specialized institutes will acquire this handsomely produced volume at the high price that must be charged in the circumstances. The hope is that enough libraries will put it on their shelves thus making the volume accessible to active workers if and when they need it. The circulation of the volume is further impeded by the fact that abstracting journals are not very likely to include detailed reviews, article by article, and one wonders how the word about its existence can be spread around. Perhaps a cheaper mode of publication, for example in the form of a research supplement patterned after the illustrious *Forschung auf dem Gebiete des Ingenieurwesens,* might provide a happier way out.

In order to bring the individual articles to the readers' closer attention, I reproduce here the Contents *in extenso*:

1. *Recommendations for the calculation of heat transfer to hydrogen, with particular reference to the design of cooled rocket motors,* H. BARROWS and W. D. MORRIS (Univ. of Liverpool) 54 pages.
2. *Precise determination of the thermal conductivity of helium gas at high pressures and moderate temperatures,* C. Y. HO and W. LEIDENFROST (Purdue University) 44 pages.
3. *Influence of mass injection of turbulent flows near walls,* E. BAKER (Pratt Institute) 96 pages.
4. *The influence of Prandtl number and surface roughness on the resistance of the laminar sublayer to momentum and heat transfer,* C. L. V. JAYATILLEKE (Imperial College) 138 pages.
5. *Survey and evaluation of techniques to augment convective heat and mass transfer,* ARTHUR E. BERGLES (Mass. Inst. of Technology) 94 pages.
6. *Optimal design of a natural-circulation boiling-water channel,* D. B. BANDY and S. G. BANKOFF (Northwestern University) 47 pages.

The first two contributions deal with correlations and measurements, respectively, of thermophysical properties. The third and fourth contributions concern themselves with turbulent flow. The last two contributions share the improvement of heat transfer as their common theme.

The praiseworthy characteristics of all six papers include a thoroughness and evident competence of the treatment as well as unusually extensive and very valuable literature references. Understandably, there is no common index. On the other hand, the papers have been, obviously, written over lengthy periods of time which, together with the publication (and review) delay, makes them somewhat dated in detail, though still indispensable for the right specialists.

The first paper correlates useful formulae for the calculation of heat transfer to hydrogen in all its forms and over a very large range of pressures and temperatures. The second paper describes the design of a very elaborate installation for the measurement of the thermal conductivity of fluids and reports them for helium over a modest range of temperatures and pressures. Both pairs of authors enter a plea for more, more precise, and more trustworthy measurements of thermophysical properties. It is, indeed, astonishing that this should be still necessary, but workers in this field know about it and are willing to make the effort given willing support. The other astonishing characteristic is the relatively minor role that statistical mechanics has so far played in reducing the need for directly measured data.

The third paper, like the second, is more in the nature of a research report even though it does include a good summary of past work, as one would expect from a doctoral thesis. More or less the same can be said about the fourth contribution, it being noted that both authors were research students under the supervision of Professor D. B. Spalding.

The fifth monograph gives a useful and thorough review of heat-transfer augmenters, including surface promoters (mechanical and chemical treatment), displaced promoters (flow disturbers away from surface), vortex flows, twisted-tape generators, vibration of the fluid or surface, electrostatic fields and various types of fluid additives.

The last paper addresses itself to the problem of optimization by the application of optimal control theory. In the problem treated, the heating section is fixed in volume and length, but the heat flux distribution and heater tube shape are optimized.

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S. V. PATANKAR and D. B. SPALDING, **Heat and Mass Transfer in Boundary Layers,** Second Edition. Intertext, London (1970).

THE INTERNATIONAL acclaim accorded to the first edition of this book has mandated a second edition which retains the proven basic approach but tightens the numerical developments, incorporates the experience gained over a three year period and extends the method to new problem areas with an evaluation of successes and a modification of failures.

Chapters I–V are almost identical to those of the first edition. Here the book derives the basic equations, casts them in a numerical form suitable for direct forward integration with a stream function-adjusted cross-wise grid for computational efficiency and introduces the concepts involved in the wall boundary conditions and the entrainment rates. The numerical approach operates essentially on three levels. The first is the basic integration approach which is quite general and overcomes most of the shortcomings of previous approaches. It is not tied to a specific turbulence model though the mixing length hypothesis is used almost throughout. The second level includes the Couette flow assumption near the wall (broadened in the new edition) and a "slip" condition which effectively surpresses the laminar sublayer in detail considerations of turbulent flows. These conditions too can be modified when the rare need arises, though at considerable peril. The third and most adjustable level includes specific points of view on entrainment rates and numerous "tricks of the trade", largely as a result of the broad experience gained.

The major changes in the new edition are the additional chapters VI–VIII. They touch all levels of the numerical procedure although they are most pronounced on the third level. Chapter VI adds a simplification of the "source" term, the inclusion of a "high lateral flux modification" which permits a more realistic expression for combined diffusion and convection effects and a better and simpler representation near the grid edge. Although the development at first appears to have changed markedly, this is more a matter of form than of substance. In addition there is a new and detailed discussion on entrainment at the free boundary, and the introduction of "wall functions" to streamline the procedure. Other extensions include provision for cross-wise pressure gradients and a slightly unconvincing heuristic discussion on confined duct flows. Chapter VII develops the philosophy of the revised programs and the overall flow charts. These are detailed for a class of mixing and burning duct flow problems in Chapter VIII which also serves as a tour-de-force illustration. The more self-consistent structure of the new programs is illustrated in an appendix where a Fortan IV listing of the duct flow problem is provided.

The wide acceptance of the previously developed program has led the authors to retain it and its documentation simultaneously with the new one. While this serves to spell out specific changes, it may also lead to some confusion by the reader first encountering the procedure.

In reviewing the first edition for the Int. Journal of Heat and Mass Transfer, Prof. Walz commented that the section covering comparisons with experiments should be expanded. Unfortunately this suggestion has not been heeded; there is only a short didactic section on recent work which re-examines the mixing length hypothesis and discusses alternatives. Readers would probably have welcomed more documentation of the wide ranging applications for which the Patankar–Spalding method has been used and some extension beyond the simple mixing length model, such as an example using the two-equation turbulent kinetic energy model.

For a book which should be used rather than just read, a few user-directed comments may be in order. The first has to be: Walk, do not run; do not be lulled by the very relaxed and pragmatic style of writing. The fundamental equations and the basic numerical approach are sound even though some detailed implementations may at first horrify a classical numerical analyst. The authors should be trusted when they claim that a detail procedure which is physically motivated and makes physical sense will also work numerically—at least most of the time. In new and untested applications, reference may sometimes have to be made to alternate, though possibly less general or efficient procedures, or the results compared cautiously to experiment. Disagreements are likely to be more a function of local approximations or of specific constants than of the basic approach. The authors' claim that the procedure is now sufficiently well developed that it may serve for computational experiments in the study of other turbulence models appears largely justified. Finally the user should not become too discouraged by the apparent lack of detail and by the absence of a directed approach; some of it was unavoidable since there is no single prescription that will fit all boundary layer problems and an attempt to be highly specific would already have outdated the book. He will have to learn to develop his own operational details for many applications and by doing so will find this book to be a significant stepping stone in boundary layer analysis and the most important and widely applicable guide currently available.

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