what is usually considered simple equipment. Not only must the measuring accuracy be high in order that processes are successful at all, but the financial consequences of inaccuracies may be considerable; contracts for many types of machine involve penalties for unexpectedly poor efficiency, and these efficiencies must often be assessed by flow measurements in closed conduits.

The finer points of conducting these measurements are thus of such industrial importance that a great body of semi-empirical information and experience has been gathered; and it was the function of a Conference at the National Engineering Laboratory of D.S.I.R. at East Kilbride in 1960 to discuss and collect this experience. The volumes here reviewed are the proceedings of the conference, which was very fully reported. For each of seven sessions the rapporteurs' statement, original papers, authors' introductions, and discussion are printed; and it is to the credit of H.M.S.O. that 767 large pages printed by a photographic process are available at such a low price. One can only complain at the long delay before publication.

It is rather noticeable to the reviewer that the great majority of contributions refer only to incompressible flow measurements and that there was little discussion on compressible flows. Some bias was deliberately given to the problem of measurement of large water flows such as are necessary for water turbine and pump acceptance tests; this has followed upon the internationally recognized work of the National Engineering Laboratory, where fundamental work into this commercially important problem has been a major interest. It is also noticeable that the mathematical treatment of the chosen topics was very simple and that most arguments were based on observations from practical experience in industry. Thermodynamicists or heat transfer engineers will probably be astonished to learn of the subterfuges used in determining large water flows in water pumps and turbines. Since conventional meters are expensive and cause a large degradation of fluid energy, indirect methods are often attempted. For example, a favourite (though controversial) method is to decelerate the flow suddenly and measure the resultant rise of pressure. Other methods include those of measuring the radial pressure gradient in the scroll case of a turbine, but here the geometry of the boundaries is anything but simple, so the interpretation of results demands considerable expertise.

A more logical and scientifically more respectable method is to inject a contaminant such as common salt, either spasmodically, and then to detect the movement of the unmixed "slugs" of fluid, or continually and measure the concentration of the mixed fluid. Many difficulties when using salt (the first and obvious pollutant) are overcome when using radioactive isotopes, and these were fully discussed.

The errors in using simple devices such as Pitot tubes, Orifices and Venturimeters were discussed in the first three sessions and very full discussions followed. A number of comparative tests on venturimeters was reported in a joint paper of the National Engineering Laboratory, and the University of Liège and the importance of standardizing upstream pipe conditions was well brought out. Another paper produced some useful information on non-circular orifices.

Finally, a section discussed the possibilities of accurate measurements by means of magnetic field flowmeters, by rotating turbine meters and by ultra-sonic means.

The overall impression given by this mass of information is one of admiration at the great amount of effort put into the problem by development engineers. No research engineer dealing with large scale flow problems should be without these volumes, including as they do some extensive and well-arranged bibliographies.

J. R. D. Francis

Proceedings of the 1962 Heat Transfer and Fluid Mechanics Institute. Stanford University Press, California, 1962, 294 pp.

The meetings of the Heat Transfer and Fluid Mechanics Institute, held annually on the Pacific Coast, provide an excellent view of the best research work being undertaken in the U.S.A. Their proceedings, swiftly published by the Stanford University Press, are invariably worthy of study by those interested in fundamental researches in heat transfer and fluid mechanics. The present volume maintains the high standard.

Because of the variety of subjects, indicated by the appended contents list, the reviewer will merely mention two papers which particularly interested him, both being concerned with transpiration cooling. Paper 3, from the Heat Transfer Laboratory of the University of Minnesota, provides a clear experimental and theoretical demonstration that thermal diffusion may not be neglected in calculations of the heat transfer to a surface which is transpiration-cooled by means of helium; for even at low Mach numbers the adiabatic wall temperature can, the authors show, be as much as 40°F in excess of the air-stream temperature. Clearly a more general expression for the recovery temperature must be used than has previously been found satisfactory.

In view of these findings, one wonders how seriously one can take the correlation put forward by Bartle and Leadon, in Paper 2. These authors carried out measurements of the reduction of Stanton number which results when gases of many kinds (including helium) are injected into a turbulent boundary layer on a flat plate. Their results are expressed in terms of the "effectiveness" (wall temperature minus coolant temperature divided by adiabatic wall temperature minus coolant temperature) plotted against the dimensionless mass-transfer rate. It is not clear how the adiabatic wall temperature was determined except in the special case of nitrogen injection. Possibly the nitrogen values were taken as generally valid, otherwise the effect reported by Eckert *et al.* would surely have been noted by Bartle and Leadon also. Incidentally, although the authors' method of plotting brings the experimental points fairly close to a single curve, close examination reveals that, at high values of the dimensionless abscissa, the "effectiveness" for one coolant may be several times as great as that of another. This must surely reduce the utility of the correlation for the designer. However, the investigation is certainly a valuable one, which will provide plenty of scope for alternative theoretical interpretations.

Contents List

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