perturbed from thermal equilibrium by supplying energy to one of the degrees of freedom. Chapter 2 gives the basic analysis which shows how measurements of the absorption and dispersion of sound waves by a gas can yield data on relaxation times. Chapter 3 describes the ultrasonic techniques by which most of the data so far has been obtained. Other experimental methods are briefly discussed in Chapter 4, including shock-wave techniques and those exciting rotational and vibrational degrees of freedom instead of that of translation.

Chapter 5 is an extremely useful compilation of relaxation data on a large number of gases, accompanied by a commentary on the experimental conditions, accuracy and reliability of the data. This chapter, and the following one on the theory, are the two main topics dealt with and take up nearly half the book.

Chapter 6 is about the theory; it is mainly concerned with simplified treatments of the complex process of energy transfer during the collision of an atom with a diatomic molecule. It requires the reader to have an elementary knowledge of quantum mechanics. The authors have aimed at keeping a good physical picture in their theoretical discussion, avoiding more rigorous theoretical treatments and refinements which can be obtained from the recent book by Herzfeld and Litovitz (*Absorption and Dispersion of Ultrasonic Waves*, Academic Press, New York and London 1959) on the subject, or from the literature.

The authors have justified the general title of the book by introducing the reader in their last chapter to the more complicated subject of energy transfer between the gas molecules involving electronically excited states which arise from irradiation or chemical reaction. The discussion of this aspect of the subject is, however, limited.

The book is an excellent introduction to the research which has been done on the subject of energy transfer between molecules in low-lying energy states, and is suitable for reading and reference by chemists, engineers and physicists alike. It is written in the style of a review of the subject, with frequent reference to the literature. It is well printed, except for some slight blemishes on pages 68–72 of the reviewer's copy.

P. L. DAVIES

Thermal Properties of Dispersed Materials: A. F. CHUDNOVSKY. M., Fizmatgiz, 1962, 456 pp., 1*r*. 68*kop*. (In Russian).

TREMENDOUS achievements in engineering urge the growing necessity to accumulate and systematize available data on thermal properties of materials and, in the first place, on thermal conductivity, temperature diffusivity and thermal capacity. Knowledge of these properties and their temperature relations is required for engineering calculations of various apparatuses and processing operations based on the solution of heat- and mass-transfer equations.

At present many authors usually give numerical data of thermal properties as Appendices to the works discussing not only heat- and mass-transfer problems but those indirectly connected with them.

However, there are a few works devoted solely to thermal properties. The book under review is such a work

While various manuals often present only numerical data, Chudnovsky pays great attention to heat conduction processes, describing methods of thermal properties determination and of their accuracy estimation.

This is the main advantageous difference of this book from usual handbooks and therefore it may be of great help for an engineer to justify his calculations.

The book consists of three parts.

The first part "The Mechanism of Physical Processes in Dispersed Materials" contains basic notions and relationships of the heat conduction theory, discussions of the processes manifesting effective character of thermal properties of dispersed materials (convection, radiation, moisture transport, etc.), a description of the contact heat conduction process, estimations of the dependence of thermal properties on voidage fraction, volume weight, moisture content and temperature.

The second part "Methods and Instruments for Determining Properties of Dispersed Materials" deals with the methods developed in this country and abroad for determination of heat capacity, stationary technique for thermal conductivity measuring, the methods based on regular thermal regime and also quasistationary and non-stationary methods for thermal properties determination of dispersed materials.

In the third part "Thermal Properties of Various Dispersed Materials" vast material is presented concerning the measurement technique and (which is of extreme importance) results of measuring thermal properties of various dispersed materials: bound materials of solid structure, as well as non-bound, fibrous, heat resistant ones.

Special chapters deal with thermal properties of semiconductors, soils, grounds, rocks and low temperatures. Various factors affecting thermal properties of the dispersed materials of the types considered are estimated.

A list of references is given after each part.

The book contains many tables, diagrams, calculations and formulae which will be certainly of great value for engineers in various fields.

A. G. SHASHKOV

Flow Measurement in Closed Conduits. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. Her Majesty's Stationery Office, Edinburgh, 2 Vols. 767 pp., 84*s*.

THE basic principles of flow measurement are usually dealt with in the earlier years of an engineering education, for they are simple and easily understood. However, the details of their application in engineering work, and the assessment of the accuracy gained under operational conditions has given many lifetimes of experience to those in industry and research. Indeed it is fair to say that most advanced processes at research or production stage depend heavily on accurate flow measurements using 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