Int. J. Heat Mass Transfer. Vol. 16, pp. 527–528. Pergamon Press 1973. Printed in Great Britain

BOOK REVIEWS

Progress in Heat and Mass Transfer, Volume IV, edited by O. G. MARTYNENKO, J. P. HARTNETT and T. F. IRVINE, Jr. Pergamon Press, New York (1971).

THIS A. V. LUIKOV Presentation Volume is compiled from papers presented at the Third All-Union Heat and Mass Transfer Conference at Minsk in 1968. Included are both reviews by rapporteurs, as well as technical papers covering a wide range of topics. The volume gives an interesting overview of Soviet research in heat and mass transfer, but the three year interval between the conference and publication dates the material and seriously detracts from its utility to the research worker. A brief description of the contents of the volume follows.

Luikov, in his opening remarks, summarizes research performed at the Heat and Mass Transfer Institute of the B.S.S.R. Academy of Sciences in the years between the second and third All-Union Conferences. Emphasis is on mass transfer in the flow of rheological fluids past a cylinder, the effect of an electric field on the hydrodynamics of liquid suspensions, and the evaporation of ice particles entrained in flow over subliming ice. Kutateladze, as chairman of the session "Heat and Mass Transfer Involving Physico-Chemical Conversions" comments briefly on turbulence and the hydrodynamics of boiling. He presents measurements of the fluctuating component of the streamwise velocity component adjacent to an impermeable flat plate which confirm a y^4 dependence of the turbulent viscosity; he suggests that this result implies a y^6 dependence at separation.

Zabrodsky, as rapporteur for the session "Heat and Mass Transfer in Disperse Systems" reviews industrial utilization of fluidized beds pointing out that present fluidization practice is far ahead of theory. Gukhman qualitatively discusses turbulent flow laminarization phenomena caused by the strong negative axial pressure gradient characteristic of transonic channel flow. Drying theory and technique is given a comprehensive but disjointed review by Lebedev and Ginzburg; included are historical aspects, current work in the Soviet Union and a few words on each of the many papers on this topic presented at the conference.

Zysina-Molozhen reviews methods for predicting heat and mass transfer in compressible turbulent boundary layers; but recent rapid progress in the West with finite difference calculation methods has rendered obsolete most of the material presented. Smolsky reports on papers concerning heat and mass transfer with liquid evaporation. It appears that this topic is still characterized by excessive empiricism; progress could be made by more detailed modeling and analysis of the simultaneous heat and mass transfer problem.

Shulman *et al.* review electrorheological effects in disperse systems and polymer solutions, and conclude that a major problem is to deduce the mechanism of structure formation and agglomeration in strong electric fields. Kim reports on use of the electrorheological effect to hold fragile objects for mechanical treatment. With a vaseline–diatomite electro-viscous film, a twenty fold increase in shear force resulted on application of the electric field. Gorislavets *et al.* analyze the rheodynamics of nonlinear viscoplastic fluid flow in circular tubes and confirm their results with experimental data taken on polymer linked varnish compositions.

Puris and Zhdanovich describe a electrochemiluminescence method for measuring velocity fields in transparent high-polymer solutions, suspensions and emulsions. The flow is probed with a thin plate anode which must be lined up in the flow direction. The luminescence intensity is proportional to the mass transfer rate at the anode, which is calculated assuming a high Schmidt number laminar boundary layer and limiting current; the possible error due to the effect of free stream vorticity is not mentioned.

Pikus reports results of a rheological study of typical emulsions used as lubricating–cooling fluids in metal working. At low shear rates the fluids display non-Newtonian behavior described by power rheological laws; at higher temperatures the non-Newtonian properties are weaker. Novichenok *et al.* measured the shear induced anisotropy of thermal conductivity for three lubricants possessing long relaxation times. In each case the conductivity was about 25 per cent higher in the molecule orientation direction than across the orientation direction, with an intermediate value in the isotropic state.

Shulman and Zaltzgendler analyze the fluid dynamics of slowly submerging a wide-angle cone into a concentric containing vessel for a Newtonian fluid, as well as for some linear and nonlinear rheological model fluids. Berkovsky *et al.* report on three studies in free convection. Experimental measurements of velocity and temperature are presented for a horizontal rectangular cavity heated from above. Numerical solutions are presented for the square cavity with various heating boundary conditions; the time dependent conservation equations were solved using the Dufort–Frankel explicit scheme. Thermoconvective waves are analyzed for a viscous heat conducting fluid, first in the absence of a magnetic field, then with a magnetic field for unity magnetic permeability and for ferromagnetic fluids.

Kolesnikov and Martynenko use wave optics to analyze the focusing of light rays by thermogaseous lenses formed by gas flowing laminarly in heated cylindrical tubes. Kolovandin and Vatutin invoke the Millionschickov hypothesis on quadruple velocity correlations to develop an approximate statistical description of non-uniform incompressible turbulent fluid flows; the set of differential equations which result are claimed to be applicable to the whole wall region. Spalding demonstrates the application to film cooling of a turbulent boundary layer finite difference calculation technique; shown are the effects of Reynolds and

Mach numbers, velocity ratio, coolant and wall temperature ratios, coolant species, free-stream turbulence and pressure gradient.

Macken and Hartnett analyze radiation–convection interaction in a low speed constant property, unity Prandtl number, laminar boundary layer; both gas and wall are gray, and emission and absorption are diffuse. In the optically thin limit, as well as for the general case, heat transfer for axisymmetric and planar stagnation points is compared to that for a flat plate; the results allow inferences to be made for intermediate wedge flows. Durst and Whitelaw review existing methods of measuring mean and fluctuating aerodynamic properties of separated gas flows. The relative advantages of the laser Doppler anemometer are listed and a new optical geometry for Doppler shift measurements is proposed.

Leidenfrost concludes the volume with a very lengthy paper describing in detail the theory, design and use of a multipurpose instrument for determining many properties including, for fluids: thermal conductivity, dielectric constant, a.c. and d.c. electrical conductivity; for gases and vapors: p–V–T properties; for liquids: thermal expansion coefficient, compressibility, vapor pressure, specific heats; for solids: specific heat. Also described is the use of the instrument for an unsteady temperature-free measurement of heat transfer and thermal transport properties.

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J. M. BEER and N. A. CHIGIER, **Combustion Aerodynamics.** Applied Science (1972). £7.00, 264 pp.

COMBUSTION research has developed rapidly during the last two decades and this progress is largely based on the application of aerodynamic principles. The combination of these two fields of sciences is presented here for the first time in the form of a book. It can be seen that it has developed to an independent discipline beside the older branches of combustion chemistry and heat exchange in reacting systems. The two authors have contributed to the work they report upon, partly at Sheffield University and partly at the International Flame Research Foundation in Ijmuiden.

Diffusion flames are normally used in practice. Their shape and properties depend on the exchange of momentum and mass. One of the main aims of fuel technology is to describe these flames, their shape, temperature fields and heat flows by means of the equations of motion. The authors show the degree to which the flame streams can be calculated despite the difficulties which arise from the existence of sources and density gradients. The reader sees the extent to which he must rely upon empiricism.

The central chapters of the book consider free jet-flames of gas with and without swirl; oil flames are also considered. Under the item "stabilisation" the premixed flames which are necessary for this process are described briefly. Additional extensive sections concern modelling and measuring systems developed specially for flames.

The book provides ready access to its topic. It collects not only the most important results of the authors and other scientists, working in similar ways, but provides additionally a very clear review of the whole field of flow and combustion.

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Fluid Dynamics Measurements in the Industrial and Medical Environment. Edited by DAVID J. COCKRELL. Leicester University Press, 1972. £5.0, 343 pp.

THE BOOK under review contains the papers from a conference held in April 1972 at the University of Leicester. There are forty-five individual contributions, including two invited lectures, one by G. Sovran on Fluid Dynamic Measurements in the Industrial Environment and the other by D. Schultz on Fluid Dynamic Measurements in the Medical Environment. Eight papers deal with biological flows. The majority of the remaining contributions are concerned with various aspects of hot wire anemometry although a significant number deal with laser–Doppler systems as well as reports on such subjects as pressure measurement and void fraction measurement intwo phase flow.

A key goal of the conference was to point out some of the myriad applications and difficulties of fluid mechanics measurements in industry. The success of this cannot be fully interpreted from the small participation of authors from industry– apparently only two of the forty-five contributions were initiated in industrial laboratories; well over half come from academic institutions and the remainder are from government research laboratories. Perhaps the promised succeeding volume containing the discussion from the conference will provide more industrial response. Sovran in his invited paper certainly does provide much insight into the complications and difficulties of measurements in industry.

It appears, however, that the gulf between the academic researcher and the engineer making industrial measurements or designing industrial instrumentation is not an easy one to cross. This is evident not only in fluid mechanics research but in a number of areas of engineering science, as well as in graduate education whose recipients in the future will be less and less entering areas of academic and pure engineering science research. The attempt by the organizers of the conference and the editor to bridge this gap is commendable. If they do not completely succeed, they are certainly in good company and the resulting volume does provide considerable information on measurement techniques which can prove useful to a number of researchers in fluid mechanics.

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