an isomorphous way. Some sub-multiplicities formed by the functions of a complex variable are the elements of this field. Expounding the operational calculus, Mikusinsky had to introduce various designations for the function and its values at some point. In the present book the convolution, in contrast to Mikusinsky, is defined in such a way that there is no need to distinguish constants from their functions. Since in some cases, when applying the Laplace integral, the various transformations and calculations connected with the determination of operational formulas become considerably simplified, one may note the relation between a constructed calculus and the Laplace transformation. This same chapter introduces concepts of an operator function, the limit of sequence of operators, the limit of an operator function. Power functions, difference equations, operator differential equations and asymptotic series are considered. New operational calculus for the operator

$$B = \frac{\mathrm{d}}{\mathrm{d}t} + \frac{\mathrm{d}}{\mathrm{d}t}$$

caused by the Bessel equation, is given at the end of this chapter. For this operator basic operational relations are obtained and its application to solving some analytical problems are given. The relation between the new operational calculus and the Meyer transformation is established.

The second part of the book includes the tables of formulae of integral transformations which are widely applied to the most diverse branches of knowledge. A list of symbols of special functions and of some constants is given before the tables of formulae. Then tables of formulae of the following integral transformations: Fourier cosine and sine transformation, transformations of Laplace–Carson, Mellin, Hankel, Meyer, Kontorovich–Lebedev etc. are cited.

At the end of the book there is an extensive bibliography which covers almost all the problems concerning the theory of integral transformations and operational calculus as well as their numerous applications (270 titles).

Summarizing the review of the book, one should say that the authors were the first who in such a volume managed to systematize the information on integral transformations and operational calculus. One can say with certainty that this book will be a handbook for a broad section of specialists such as: mathematicians, physicists and engineers interested in problems of applied mathematics.

A. V. LUIKOV

Evaporative Cooling of Circulating Water. L. D. BERMAN, Pergamon Press, Oxford, 1961, 392 pp. 140*s*.

THE object of this book, translated from the 1956 edition of the Russian text first published in 1949, is to provide a systematic account of the theory, design and use of cooling methods for water, particularly in connexion with steam power plant. Most of the material is concerned with forced- and natural- convection cooling towers, but attention is also paid to cooling in open reservoirs and in spray tanks.

The merit of such a volume can be judged in two ways: by consideration of the extent to which it aids the design of equipment; and by comparison with other published works on the same subject. These two methods will be used in turn in the present review, consideration being confined to cooling towers.

The task of designing a cooling tower is as follows: the mass flow rate of water and its inlet and outlet temperatures are specified, together with the temperature and humidity of the available cooling air; the tower shape and the type and quantity of packing have to be chosen, together perhaps with the fan capacity; and the capitalized cost of the plant has to be kept to a minimum. The design calculation has two phases: the analysis of the performance of a selected tower-plus-packing assembly to meet the required specification; and the systematic variation of the design parameters to minimize the cost. In both these phases the designer needs, on the one hand, appropriate mathematical methods, and, on the other, tabulations of data such as packing pressure drops, heights of a transfer unit, and costs of construction.

The book under review is definitely weak on the economic side. Although a few scattered cost data are given, no optimization methods are presented. The technical aspects of tower analysis are treated much more fully; for example, heat transfer coefficients and pressure drops are tabulated for a great many packing types, although unfortunately they are not tabulated side-by-side so that the reader has to work hard in order to assess the merit of a particular packing. This reviewer was disappointed not to find the "transfer unit" concept mentioned or used, although of course it appears implicitly in the equations which are solved. Incidentally, the differential equations for counterflow towers are studied in almost excessive detail; three slightly different methods of solution are presented, all of them making use in one way or another of the technique of linearization. Cross-flow towers are also treated, but without derivation of the solution presented.

The designer of a cooling tower has to pay great attention to the pressure drop and distribution of the air stream, a difficult task when the air enters in a horizontal direction at the base of the tower and must then turn through a right angle before flowing through the packing. The author of the book devotes several pages to the air-entry problem, writing down the equations governing the flow and presenting experimental data for various air-inlet arrangements; unfortunately the equations are not solved, nor could they be in the absence of values for the coefficients appearing in them; and the experiments are not reported in sufficient detail for the designer to be able to apply their results to any particular problem. This is altogether a tantilizing passage.

When the cooling tower is of the natural-draught type common in Europe, the task of designing it is particularly difficult, since the air-flow rate is dependent in a complex way on the tower dimensions, packing characteristics and inlet air and water conditions. Although Professor Berman discusses such towers at some length, he never

gets to grips with the actual problem; the equations which are presented are not solved, the designer being recommended to make use of some empirically constructed graphs for the determination of the packing area, etc. Of course, if the graphs displayed the influence of all the important variables, such a method would be quite adequate; unfortunately they do not, so it is hard to see how design improvements can be effected by their use. It should be mentioned that methods for the complete calculation of natural-draught towers do exist, that of Chilton (*Proc. Inst. Elec. Engng, London*, **99**, Pt. II, No. 71, October 1952) being perhaps the simplest and most satisfactory; this method, which appeared after the first edition of the present book but before the second, is not referred to by the author.

The problem of distributing up to 7×10^7 lb of water per hour to the packing of a tower of, say, 250 ft diameter, without causing excessive obstruction to the air flow or a prohibitive pumping cost, is a formidable one. The book under review describes a great many arrangements for doing this which the designer can study with profit; as indicated above, however, he will have to work out for himself procedures for calculating which arrangement is cheapest. There are also descriptions of sprayers (with regrettably few data on their characteristics), a discussion of de-icing methods, and many pages on maintenance problems such as the combatting of organic growth.

Judged by the first of the two standards mentioned above, the book must be held to be but partially successful; the text is annoyingly and unnecessarily incomplete in many matters of detail; and designers are left without quantitative guidance in several matters of substance. When the book is judged by the second standard however, far more favourable remarks are in order; indeed the author knows of no single volume which contains so much sound and varied information on cooling-tower design. The drawings of actual installations, and the author's unusual grasp of both the theoretical and experimental aspects of the problem, are particularly to be commended. The translation is excellent.

D. B. SPALDING

Non-Newtonian Fluids. Fluid Mechanics, Mixing and Heat Transfer. W. L. WILKINSON, Pergamon Press, 1960, 138 pp. 37*s*. 6*d*.

THIS is an elementary and lucidly written textbook on those aspects of non-Newtonian fluid flow presently of primary interest to the chemical engineer. The book is subdivided into six chapters: Classification of non-Newtonian fluids; Experimental characterization of non-Newtonian fluids; Flow of non-Newtonian fluids in pipes and channels; Heat transfer characteristics of non-Newtonian fluids; Mixing characteristics of non-Newtonian fluids; Viscometric measurements and apparatus. Each contains a clear presentation of the subject matter and includes most of the pertinent literature references.

It is of course recognized that the field of non-Newtonianism embraces all the many possible deviations from the simple Newtonian proportionality between stress and rate of strain. It has, as a consequence, developed into a broad and complex discipline with many branches which often are treated as distinct topics. One such area is concerned for example with the problem of how the rheological equation of state of a substance is dependent upon its molecular structure, and to what extent slight changes in the chemical composition of a fluid can affect its rheological properties. Another is the important question of the possible influence of viscoelasticity on the state of motion of a non-Newtonian fluid and the conditions under which viscoelastic effects become the primary cause for the unusual rheological phenomena which are sometimes observed with such substances. And clearly there is always the intriguing problem of determining, for a three-dimensional flow, the most general form of a rheological equation of state which would also be compatible with the rather obvious but absolutely essential restrictions of invariance with respect to rotation of the co-ordinate axes.

In a field then which is so vast, it becomes quite necessary for the author of a short and elementary textbook to drastically limit himself to a small segment of this sprawling subject. Dr. Wilkinson has elected to remain for the most part in an area which may be termed fluid flow and to dwell upon the engineering aspects of the field while, by necessity, omitting some of the more peculiar and fascinating topics such as those mentioned above. The one-dimensional model is used exclusively and, although a few things are said about viscoelasticity, the bulk of the book is restricted to an equation of state which expresses the stress as a function only of the rate of strain. In this manner, for example, the well-known Poiseuille equation for the laminar pressure drop in a pipe is extended to non-Newtonian fluids and a similar generalization is presented for the familiar friction factor plots.

In some respects this book is an extension of an earlier article by A. B. Metzner in Volume I of *Advances in Chemical Engineering*, and emphasizes the engineering approach to the subject. It is indeed a pleasingly well written and readable introduction to this topic which will appeal to not only many a practising engineer but also to those students who, having been exposed to some of the elements of Newtonian fluid flow, would want to obtain a glimpse of this increasingly important and fascinating area of non-Newtonianism.

A. ACRIVOS

Mollier-*i,x*-Diagramme für feuchte Luft. H. D. BAEHR. Springer-Verlag, Berlin, 1961, 22 pp. + iii. DM12.

THE Scientific Subcommittee of the Institution of German Engineers (VDI) has recently recommended the introduction of the international system of units (the MKS-system). The extent to which this recommendation can be put into practice depends largely on the availability of