BOOK REVIEWS


REVIEWED BY D. D. JOSEPH

Rheological fluid mechanics is an intellectually interesting and technologically important subject. The reason that this subject has not come to a more central place in fluid mechanics is because of uncertainty about the correct form for the governing equations. Constitutive relations which are general enough to describe the tremendously varied responses open to a rheologically complex fluid are too general to solve many problems. And specific constitutive equations, developed from models, suitable for problem solving, are at best guided guesses which leave open the ultimate question about whether the constitutive relation you give is the right one for the fluid you got. Authors have had to decide between a good treatment of principles, without much problem solving, and a good treatment of fluid models, emphasizing problem solving. In the first category the treatise by Truesdell and Noll (The Nonlinear Field Theories of Mechanics, Springer, 1965) is without peer; in the second category are the books of Lodge (Elastic Liquids, Academic Press, 1964), and Middleman (The Flow of High Polymers, 1968).

The book by Astarita and Marrucci follows the line of thought developed by Truesdell and Noll, but from their own more pragmatic point of view and with some attention in the last two of seven chapters, to methods of approach toward solving important problems in the fluid mechanics of non-Newtonian fluids. The book is simply and clearly written. The arrangement of material is good and the book may be read, cover to cover. The technical arrangements for printing text, equations, and notes is outstanding and, in this, the authors and McGraw-Hill have produced an excellent work.

Non-Newtonian Fluid Mechanics cannot, of course, be compared to the Nonlinear Field Theories in breadth, rigor, and depth of scholarship. But the Truesdell and Noll book is full of new concepts, notations, and modes of thought and to say the least, demands more than some ordinary folk can give and more than less-ordinary folk will give. Since understanding is always incomplete, and in this, the authors and McGraw-Hill have produced an excellent work.

Non-Newtonian Fluid Mechanics does not come into a more central place in fluid mechanics is because of the well-known viscometric flows are a special case, are discussed, and simple explicit examples are given in Chapter 3. Chapter 4 is about simple fluids, fading memory, and thermodynamics. Chapter 5 is about the special flows which rheologists use to characterize fluid properties: viscometric flow, extensional flow, and periodic flow. Chapter 6 contains a good discussion of constitutive equations. Rate equations and integral equations of the memory type are discussed and compared. The model equations of Maxwell and Oldroyd are discussed and compared with simple fluids. The discussion in Chapter 6 is critical and the criticisms which are raised are important. Chapter 7 deals with methods of approach to the solution of problems of fluid mechanics; dimensional analysis, superposed flows, flow around submerged objects, boundary layers, turbulence, waves, and stability.

Non-Newtonian Fluid Mechanics by Astarita and Marrucci is an excellent addition to the developing literature on the application of general principles of nonlinear continuum fluid mechanics to the problems of fluid mechanics. The main value of the book is the discussion of the principles which are necessary as a preliminary to problem solving. The application of these principles to problems is currently in an active period of development and this new book will certainly help in the effort to make the theory of the simple fluid into a practical fluid mechanics.


REVIEWED BY J. LAWRENCE KATZ

This excellent monograph by two well-known solid-state physicists provides a much needed unified account of anelasticity in crystals. The first six chapters provide a clear and thorough treatment of the formal theory of anelasticity. As the authors suggest, these chapters could provide the basis for an excellent graduate course in this area. Starting with a set of formal definitions, the authors introduce the important response functions which are used to describe the anelastic solid under appropriate experimental conditions. Following with the Boltzmann Superposition Principle they develop the relationships between the response function. This leads into models including the standard anelastic solid with a thorough development of its dynamic properties including temperature dependence. After a discussion of continuous spectra considering both direct and indirect methods of calculation, the authors develop the interrelationships between relaxation spectra and the existence of a set of internal variables by applying irreversible thermodynamics to relaxation phenomena. The introductory portion closes with a tensor treatment of anisotropic elasticity and anelasticity. Here, the authors begin to introduce some of the application to crystalline systems by treating several crystal systems of high symmetry in order to express the various "practical" moduli in terms of the characteristic elastic compliance and stiffness constants. Chapter 7 then acts as a transition chapter introducing the concept of point defects and models of atom movement. Chapters 8-11 then deal with those relaxation phenomena which arise due to point defects; the Snoek and Zener relations are each given a whole chapter. Some background in crystallographic symmetry or group theory would prove quite useful at this point as indeed it would have in Chapter 6 as well. For those not formally grounded in solid-state physics some introductory texts might prove useful for background reading at this point. Chapters 12-15...