Thermodynamics


REVIEWED BY R. L. FOSDICK

The major concern of this six chapter Springer Tract in Natural Philosophy is contained in the middle four chapters, and is devoted to a clear description of two separate approaches to the rational theory of continuum thermodynamics for materials with memory—the author’s own theory, and that established earlier by B. D. Coleman. The essential conceptual difference between the two approaches is related to the form of the fundamental postulate which represents the second law. In Coleman’s theory the concept of entropy is introduced as a primitive field variable and the Clausius-Duhem inequality is adopted for the second law. Day, however, postulates a thermodynamic inequality which is not only less restrictive, but which also does not demand the a priori notion of entropy. In Day’s theory, the idea of entropy enters as a derived concept for both equilibrium and nonequilibrium situations, and he is able to show that many of its properties are equivalent to those which Coleman observed in his fundamental work of 1964.

Chapter 1 contains a brief review of some helpful mathematical tools, and provides a concise description of the elementary kinematics and balance laws of continuum mechanics. In addition the general constitutive assumptions for materials with memory are introduced.

Chapters 2-4 are devoted to a description of the author’s own theory of thermodynamics for materials with fading memory. Independent of the concept of entropy, a thermodynamic inequality representing the second law is postulated and its implications regarding heat-conduction inequalities and the conversion of heat into mechanical work are established. In addition, a physically motivated constitutive restriction representing the idea of fading memory, and sufficiently weak to include, for example, materials of differential type (classical viscous fluids is one such material), is introduced. The notion of entropy is established as a derived concept and, as an illustration, it is explicitly constructed for elastic materials, materials of differential type, and for a special class of viscoelastic materials.

Chapter 5 is independent of the previous chapters in that here the notion of entropy is taken as a primitive concept and the Clausius-Duhem inequality is assumed. The thermodynamics of materials of differential type is briefly treated as an introduction to the more difficult situation of materials with fading memory. Coleman and Noll’s notion of fading memory is adopted and Coleman’s theory of thermodynamics is fully developed. The chapter concludes with a brief comparison between the results of the two thermodynamic theories presented in this book.

The sixth and final chapter contains a detailed analysis of the implications concerning thermodynamic admissibility and the assumption of dissipative relaxation functions for the theory of isothermal linear viscoelasticity. While the author notes that the subject matter of this monograph could be treated as a formal mathematical structure based on consistent and precise axioms and supported by theorems, he has elected to present the material in a lighter vein emphasizing physical assumptions wherever possible. Rigor is not sacrificed by his approach.

Structural Matrix Analysis


REVIEWED BY J. S. PRZEMIEŃIECKI

Elastostatics and Elastokinetics in Matrix Notation—Transfer Matrix Method is a brief introduction to the specialized matrix structural analysis of systems which consist of a number of elements linked together end to end in the form of a chain. For such systems, the transfer matrix method of analysis requires only that successive matrix multiplications be performed to fit the elements together and to obtain the static and dynamic characteristics of the assembled system. The size of the transfer matrices is dependent only on the order of the differential equations governing the behavior of the element and consequently all matrix operations can be performed with a minimum of computational effort. The application of the transfer matrix method is illustrated for elastic bars, beams, and for some plate and shell problems. In addition, a brief discussion of the analysis of coupled or branched systems is included, e.g., closed ring structures. The text contains also Appendices on matrix algebra, eigenvalues and eigenvectors, and solution of linear differential matrix equations of the first order. For any further details of the transfer matrix analysis of structures, the reader may consult Matrix Methods in Elastomechanics by Pestel and Leckie, McGraw-Hill, New York, 1963.

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