ChE book reviews

FOUNDATIONS OF CONTINUUM THERMODYNAMICS

J. J. Delgado Domingos, M. N. R. Nina, J. H. Whitelaw, eds. Halsted Press, 1973. $29.95

Reviewed by J. C. Melrose, Mobil Research and Development Corp.

This volume constitutes the proceedings of an International Symposium on the Foundations of Continuum Thermodynamics, held in Bussaco, Portugal, in 1973. Contributors to the proceedings include many of the most prominent physicists, chemists, engineering scientists, and applied mathematicians who have been active in this field in recent years. A slight majority, perhaps, of the papers will appeal primarily to those chemical engineers who adhere to the traditional view of both equilibrium and non-equilibrium thermodynamics. According to this view, thermodynamics provides a framework within which the phenomena of molecular physics are manifested as relationships among macroscopic parameters. The remainder of the papers, on the other hand, will be of primary interest to those who find inspiration in the various degrees of mathematical complexity by which the so-called constitutive relationships of continuum mechanics can be formulated.

Among the contributors who approach the subject primarily from the point of view of molecular or statistical theory are Tisza, Callen, Prigogine, Schlogl and de Groot. The papers by these authors, along with that by Professor J. Meixner, a founder of the subject of irreversible thermodynamics, form the centerpiece of the Symposium proceedings. Protagonists representing the continuum mechanics point of view include Muller, Rivlin, Lee, Nemat-Nasser, Mandel and Pina. An introductory paper by the principal organizer of the Symposium, Professor Delgado Domingos of Lisbon, is a noteworthy review of current conceptual problems in the latter field.

An interesting feature of the book is the inclusion of five discussion papers, as well as contributions in the form of discussion remarks. These follow nine of the eleven principal contributions. A summary paper by P. Germain deals with what was intended to be a major objective of the Symposium. This objective was the reconciliation of the vastly different approaches to the physical foundations of thermodynamics which are commonly followed by the practitioners of the two schools of mechanics: statistical and continuum. Since Germain is a representative of the latter school, his desire "to conclude on a peaceful note" is refreshing.

As may be inferred, this book is not recommended for students who are just beginning a study of the subject of thermodynamics. On the other hand, it can be highly recommended to those who, with teaching responsibilities, are perplexed by the differing approaches just alluded to. Of particular value, in the reviewer's opinion, are the discussion paper and discussion remarks of Professor J. Kestin of Brown University. Kestin points out some common difficulties of a semantic nature and stresses the importance of using terms such as thermodynamic state and thermodynamic process in a precisely defined and consistent way.

For those who may be intrigued by the appearance of greater generality which is engendered by the mathematical formalism of continuum mechanics, the two papers by D. G. Miller of the Lawrence Livermore Laboratory and E. A. Mason of Brown University are recommended. Miller's contribution reviews the present status of the experimental evidence for the validity of the Onsager reciprocal relations. Miller also discusses the well-known criticisms of irreversible thermodynamics by certain practitioners of the school of continuum mechanics. He concludes that these criticisms are overstated and issues a challenge to this school to supply arguments of a macroscopic nature by which the reciprocal relations can be derived. Professor Mason in his discussion paper provides some stimulating arguments to support Miller's challenge and suggests that the Onsager reciprocal relations be elevated to the status of a scientific paradigm (to adopt the terminology of T. S. Kuhn).

As a final comment by one who has attended several conferences of the syncretistic type represented by the Bussaco Symposium, this reviewer would like to put forward the following proposition. Stated as a theorem of unattainability, the proposition is that the ostensible objective of such a conference can never be achieved. The backgrounds, favorite approaches, and basic interests of the two schools are ultimately too divergent to be reconciled. This is not to say that this and previous conferences have not been highly successful. On the contrary, the proceedings of the Bussaco Symposium provide a stimulating record of what was clearly an outstanding meeting, devoted to one of the most central subjects in physical science. □