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Book Reviews

Mechanical Behavior of Engineering Materials, Vol. 1: Static and Quasi-Static Loading

Yehia M. Haddad, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2000, 420 pp., $210.00

As stated by the author, the purpose of this monograph is to introduce the reader to the principles of the mechanical response of various classes of materials. The subject matter is presented in two volumes, with Volume 1 reviewed herein. This volume contains eight chapters and three appendices with focus on both the static and quasi-static response of materials. The introductory section discusses the basic content of the two volumes along with notional concepts associated with classifying the mechanical response of materials. Chapter 1 deals with an introduction to Cartesian tensors, with Appendix A included for discussion of curvilinear tensors. Chapter 2 examines the mechanical approaches used in the study of the mechanics of deformable media. The basic assumptions and principles of continuum mechanics are introduced and then used throughout the text. Chapter 3 focuses on the response of engineering materials to mechanical loads, including deformation and flow characterization. Chapter 4 discusses the basic structure of the classical theory of thermodynamics and the constraints imposed by the theory on deformable solids.

Chapter 5 examines the mathematical description of the material behavior of deformable solids. Concepts associated with constitutive equation development are discussed, along with ties to the material presented in Chapters 1–4. Chapter 6 explores the time-independent elastic response of materials. The classical linear/nonlinear responses of applicable constitutive laws are presented. Basic elements of formulating the boundary value problem in elasticity are discussed. Chapter 7 extends the preceding discussion of elastic material behavior to include the effects of inelastic deformation. Idealized models of elastic–plastic behavior are presented, along with the introduction of a yield surface. The effects of temperature as related to material deformation are discussed, along with the classical notions of the creep behavior of materials in a thermal environment. Chapter 8, the concluding chapter of Volume 1, examines the time-dependent response of materials; that is, the subject of viscoelasticity is introduced with linear viscoelastic behavior discussed extensively and example problems included. The transition to thermoviscoelasticity and the rheological behavior of materials is also introduced. The three appendices include a discussion of curvilinear tensors, Dirac delta functions, and integral transforms, respectively.

In summary, this volume contains the basic elements necessary for characterizing the behavior of deformable solids subjected to static and quasi-static loads. Each chapter contains a representative list of references along with excellent notional ideas related to assumptions used in the development of the models introduced to describe classes of material behavior. These concepts are presented throughout each chapter and should serve both practicing scientists and engineers, as well as students, in grasping the basic elements needed in the formulation of the theoretical models described. Some topics that could be expanded upon include the relevance of introducing tensor rotation to modeling the behavior of materials; a discussion of inhomogeneous, anisotropic materials in Chapter 2; the distinction between small and large strains in Chapter 7; and representative worked problems interspersed in Chapters 5–8. A number of chapters include problems that could be used as assignments when the book is used as a text. Although the intended users of the book are not clearly articulated, this reviewer feels that the volume can be used for extended learning by scientists and engineers and as a classroom text.

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Heat Exchanger Design Handbook

T. Kuppan, Marcel Dekker, New York, 2000, 1092 pp., $225.00

The performance of heat exchangers for both industrial and domestic applications is increasingly important as the demand for energy and energy exchange increases. As a consequence, the consolidation of recent information on heat exchanger characteristics and performance will be extremely useful in optimizing the design of new heat exchangers for enhanced performance, as well as improving the performance of existing heat exchangers. Although there have been other compilations of material related to heat exchanger performance data and design techniques, many of these have not kept pace with recent design practices. The present volume has endeavored to assemble appropriate technical information from recent literature, industrial bulletins, codes and standards, and other sources to provide a cohesive summary of design information and practices with appropriate supporting documentation. This volume is restricted to single-phase flow conditions for most types of traditional heat exchangers, although it is directed primarily toward shell and tube heat exchangers. Major areas of the book deal with the fundamentals of heat exchangers; selected types of heat exchangers; characteristics that impact heat exchanger performance; and the fabrication, testing, and operation of heat exchangers.

The first section deals with the classification and selection criteria for heat exchange equipment that may be used for a broad range of applications. The more traditional types of heat exchangers, such as the shell and tube, compact, regenerator, and plate and frame heat exchangers, are discussed in terms of general applications. Specialized types of heat exchangers including the double-pipe, heat pipe, spiral, lamella, glass, graphite, Teflon, and jacketing exchangers are discussed in terms of specific applications in Chapter 1. Successful design of heat exchangers requires knowledge of the thermal and fluid flow fundamentals. Therefore a discussion of the thermal resistance variables, overall conductance equations, temperature distribution, mean temperature difference, temperature correction factors, number of transfer units, and effectiveness formulas for selected flow arrangements, flow passes, and operating conditions is provided for selected heat exchanger types in Chapter 2. Specific characteristics related to heat exchanger design methodology are discussed in Chapter 3, including the sizing and rating, pressure drop and fluid flow parameters, fluid property corrections, and other factors that influence the uncertainties in the design.

The second major area of the book focuses on the primary types of heat exchangers and their applications, specifically compact, shell and tube, regenerators, and plate heat exchangers. Inasmuch as space for heat exchangers is often limited, the need for economical, high-performance, lightweight units has led to a class of heat exchangers designated as compact heat exchangers. These heat exchangers often utilize atmospheric air as one of the fluids, resulting in the development of special surface geometrical factors, fin efficiencies, ratings, sizing, and associated design considerations as shown in Chapter 4. For high-pressure, high-volume operating conditions, shell and tube heat exchangers are used throughout industry. Chapter 5 reviews the special design considerations for shell and tube heat exchangers, including construction features, baffle arrangements, geometrical considerations, and operating criteria. There are numerous occasions when it is desirable to recover waste heat using a class of heat exchangers designated as regenerators. The types of regenerators, range of applications, thermal and mechanical design considerations, and construction details are discussed in Chapter 6. For moderate operating conditions, plate heat exchangers are an alternative to shell and tube heat exchangers and provide economical performance characteristics for the food processing and pharmaceutical industries and are used in many other industrial applications, as described in Chapter 7.

The next section of the book deals with parameters that impact heat exchanger performance, including techniques for augmentation of heat transfer, prevention and control of fouling, and control of flow-induced vibrations. Numerous techniques have been proposed for heat transfer augmentation to improve the performance of heat exchangers, and some of these surfaces and augmentation devices are discussed in Chapter 8, although with limited comparisons. Inasmuch as fouling of heat exchanger surfaces impacts the overall performance and introduces uncertainty into the design process, Chapter 9 reviews the various fouling mechanisms, potential prevention techniques, and control mechanisms. Flow-induced vibrations in shell and tube heat exchangers can lead to tube failure; flow-induced vibration characteristics, their evaluation, and control and prevention guidelines are discussed in Chapter 10 because of their importance in heat exchanger design.

The last section of the volume deals with the overall design of shell and tube heat exchangers, the selection criteria for heat exchanger materials, quality control and quality assurance, and fabrication practices. Chapter 11 discusses the overall heat exchanger mechanical design including determination of the minimum thickness requirements for heat exchanger components, stress analysis of the components, and codes and standards for tubesheets and pressure vessels. Because corrosion is another factor that adversely affects both the life and performance of heat exchangers, corrosion principles, evaluation, and monitoring, as well as corrosion control and prevention, are reviewed with a primary focus on cooling-water corrosion in Chapter 12. Because heat exchangers are used in a wide range of environments with a variety of fluids and operating conditions, materials must be selected to suit the requirements for thermal performance, strength, ease of fabrication, safety, and heat exchanger life. Chapter 13 proposes and discusses material selection criteria. Inasmuch as the safety of heat exchangers is of paramount importance, quality control and quality assurance in the manufacturing process are essential, and inspection and nondestructive testing techniques are reviewed in Chapter 14. Fabrication techniques and shop floor practices are equally important in producing quality heat exchangers, and these practices are identified and discussed in Chapter 15.

In summary, this handbook provides a reasonable treatment of the heat exchanger design process and provides a wealth of material that is well organized with a logical progression of topics. Although the volume is directed primarily toward shell and tube heat exchangers, other types of heat exchangers are included. Some chapters provide a comprehensive review of the subject, whereas other chapters provide only selected treatment of the material. There are references and a bibliography for each chapter, which may be pursued for additional information. The handbook will be useful for those who are responsible for the design of heat exchangers as well as those who deal with the acquisition and renovation of heat exchangers.

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