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ASM Handbook Volume 4D is the fourth of five volumes to be published on heat treatment. Volume 4A covers the basic fundamentals and processes of steel heat treatment, while Volumes 4B and 4C cover the technological aspects of steel heat treating in terms of basic furnace system and controls (Volume 4B) and induction heating and heat treatment (Volume 4C).

Volume 4D concludes the coverage on ferrous heat treatment with over 40 articles on the heat treatment and properties of the many different types of steels and cast irons. The process of steel selection for direct hardening and surface hardening also is covered in more detail. This gives designers and heat treaters more data and reference information for both component and process design.

We thank the volunteer editors, authors, and reviewers for participating in this enormous effort. The result is a substantive reference work that reflects the continuing commitment of the Heat Treating Society and ASM International in serving technical communities with the tools to solve problems. We are especially indebted to the Volume Editors, Jon Dossett and George E. Totten.

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Preface

During the review of the *ASM Handbook, Volume 4, Heat Treating* published in 1991, it was apparent that just one volume could not accommodate updates and improvements in coverage. Better coverage on ferrous heat treatment necessitated an increase in scope, and coverage of nonferrous heat treatment could not be shortchanged. Furthermore, just the subject of steel treatment fundamentals and processes contained enough useful reference information for one volume, given the large collection of original references published by ASM International (and formerly the American Society for Metals) on steel heat treatment. Equipment, furnace technologies, process control and problems, and induction were other major topics that warranted separate volumes, even before addressing the particular processing and properties of the many types of heat treated iron and steels.

From this enormous effort, *ASM Handbook, Volume 4D, Heat Treating of Irons and Steels* concludes the *ASM Handbook* print volumes on ferrous heat treatment—but which will still be followed by Volume 4E, *Heat Treating of Nonferrous Alloys*, in development for publication in 2016. This volume details the heat treatment and properties of the many different types of steels and cast irons and describes the processing and properties that influence the selection of steels for heat treatment. Updates are part of this new Volume, but content also is significantly expanded in several ways. For example, new articles are devoted to the industrially significant topics of gear and bearing steel heat treatment. New articles address the heat treatment of boron steels, copper steels, and forged steels, and coverage is expanded on the workhorse carbon and low-alloy steels. In addition, the heat treatment of tool steels and stainless steels is covered much more extensively. This represents a major update, although we still recognize some compromises in scope and effort as inevitable.

In acknowledging this effort, we thank all the editors, authors, reviewers, and the supporting staff of ASM International. We are especially indebted to the following editors who were instrumental in this overall effort:

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Policy on Units of Measure

By a resolution of its Board of Trustees, ASM International has adopted the practice of publishing data in both metric and customary U.S. units of measure. In preparing this Handbook, the editors have attempted to present data in metric units based primarily on Système International d’Unités (SI), with secondary mention of the corresponding values in customary U.S. units. The decision to use SI as the primary system of units was based on the aforementioned resolution of the Board of Trustees and the widespread use of metric units throughout the world.

For the most part, numerical engineering data in the text and in tables are presented in SI-based units with the customary U.S. equivalents in parentheses (text) or adjoining columns (tables). For example, pressure, stress, and strength are shown both in SI units, which are pascals (Pa) with a suitable prefix, and in customary U.S. units, which are pounds per square inch (psi). To save space, large values of psi have been converted to kips per square inch (ksi), where 1 ksi = 1000 psi. The metric tonne (kg \(\times 10^3\)) has sometimes been shown in megagrams (Mg). Some strictly scientific data are presented in SI units only.

To clarify some illustrations, only one set of units is presented on artwork. References in the accompanying text to data in the illustrations are presented in both SI-based and customary U.S. units. On graphs and charts, grids corresponding to SI-based units usually appear along the left and bottom edges. Where appropriate, corresponding customary U.S. units appear along the top and right edges.

Data pertaining to a specification published by a specification-writing group may be given in only the units used in that specification or in dual units, depending on the nature of the data. For example, the typical yield strength of steel sheet made to a specification written in customary U.S. units would be presented in dual units, but the sheet thickness specified in that specification might be presented only in inches.

Data obtained according to standardized test methods for which the standard recommends a particular system of units are presented in the units of that system. Wherever feasible, equivalent units are also presented. Some statistical data may also be presented in only the original units used in the analysis.

Conversions and rounding have been done in accordance with IEEE/ASTM SI-10, with attention given to the number of significant digits in the original data. For example, an annealing temperature of 1570 °F contains three significant digits. In this case, the equivalent temperature would be given as 855 °C; the exact conversion to 854.44 °C would not be appropriate. For an invariant physical phenomenon that occurs at a precise temperature (such as the melting of pure silver), it would be appropriate to report the temperature as 961.93 °C or 1763.5 °F. In some instances (especially in tables and data compilations), temperature values in °C and °F are alternatives rather than conversions.

The policy of units of measure in this Handbook contains several exceptions to strict conformance to IEEE/ASTM SI-10; in each instance, the exception has been made in an effort to improve the clarity of the Handbook. The most notable exception is the use of g/cm\(^3\) rather than kg/m\(^3\) as the unit of measure for density (mass per unit volume).

SI practice requires that only one virgule (diagonal) appear in units formed by combination of several basic units. Therefore, all of the units preceding the virgule are in the numerator and all units following the virgule are in the denominator of the expression; no parentheses are required to prevent ambiguity.
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