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Metallic materials — Conversion of hardness values

Matériaux métalliques — Conversion des valeurs de dureté

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Foreword

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The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This second edition cancels and replaces the first edition (ISO 18265:2003) which has been technically revised.

Introduction

The hardness conversion values given in Table A.1 were obtained in interlaboratory tests by the *Verein Deutscher Eisenhüttenleute* (VDEh) (German Iron and Steel Institute) using verified and calibrated hardness testing machines. Statistically reliable information cannot be given on the uncertainty of these values because the test conditions were not reproducible, and the number of results used to calculate the mean hardness values is not known. The conversion values in this table are in accordance with the information presented in IC No. 3 (1980) and IC No. 4 (1982) of the European Coal and Steel Community, as well as in ISO 4964:1984 and ISO/TR 10108:1989.

Annexes C, D and E contain – in a revised format – the extensive results on the conversion of hardness values presented in TGL 43212/02 to 43212/04, standards published by the former East German standards body, the *Amt für Standardisierung, Meßwesen und Warenprüfung* (ASMW). The values presented in Annex B had also been determined by the ASMW, but were published in a report of the *Physikalisch-Technische Bundesanstalt* (PTB),[1] the German national institute for science and technology, not in a TGL standard.

The converted hardness values in the above-mentioned TGL standards were obtained in statistically reliable hardness and tensile tests. The hardness tests were performed using ASMW normal testing machines on plane-parallel, polished specimens of various materials in different heat treatment conditions. Tensile strength was tested on machines whose force measuring and extension measuring systems had been calibrated immediately before testing. The tensile test method used is equivalent to that specified in ISO 6892-1, and the calibration procedures conform with those specified in ISO 7500-1 and ISO 9513.

Annex G contains the results on the conversion of hardness values of two tool steels with the assistance of the *Verein Deutscher Eisenhüttenleute* (VDEh) which were obtained in the year 2007.

Users of this International Standard should take note of Clause 2, especially the concluding warning.

Metallic materials — Conversion of hardness values

1 Scope

This International Standard specifies the principles of the conversion of hardness values to equivalent values in other hardness scales and to estimates of tensile strength. It gives general information on the use of the conversion tables.

The conversion tables in Annexes A to G apply to

— unalloyed and low alloy steels and cast steel,

— steels for quenching and tempering,

— steels for cold working,

— high speed steels,

— tool steels,

— hardmetals, and

— non-ferrous metals and alloys.

NOTE 1 The conversion tables in Annexes B to G are based on empirical results which were evaluated by means of regression analysis. Such analysis was not possible in the case of the values given in Annex A because a sufficient number of results was not available.

NOTE 2 Annex H gives information about the effects of changes of the test procedure in the standards specifying the hardness tests.

Converted values obtained using this International Standard are only directly applicable to the exact material tested. For all other materials, they provide an indicator only. In all cases, the converted values are not intended as replacements for values obtained by the correct standard method. In particular, tensile strength estimates are the least reliable converted values in this International Standard.

Sections of this International Standard are reprinted, with permission of ASTM International, from ASTM E140 *Standard Hardness Conversion Tables for Metals Relationship among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Harness, Knoop Hardness, and Scleroscope Hardness*.

2 Principles of conversion

Hardness testing is a form of materials testing that provides information on the mechanical properties of a material with limited destruction of the specimen and within a relatively short period of time. In practice, it is often desirable to use hardness results to draw conclusions on the tensile strength of the same material if tensile testing is too involved or the piece to be examined is not to be destroyed.

Since the means of loading in hardness testing is considerably different from that in tensile testing, it is not possible to derive a reliable functional relationship between these two characteristic values on the basis of a model. Nevertheless, hardness values and tensile strength values are positively correlated, and so it is possible to draw up empirical relationships for limited applications.

Often it is necessary to check a given hardness value against a value gained by a different test method. This is especially the case if only a certain method can be used due to the particular specimen or coating thickness, the size of the object to be tested, surface quality, or the availability of hardness testing machines.

Conversion of hardness values to tensile values makes it possible to carry out hardness measurement in place of the measurement of tensile strength taking into account that these tensile strength values must be seen as being the least reliable form of conversion. Likewise, with conversion between hardness scales, a hardness value can be replaced with a value obtained using the desired method.

Sometimes a conversion relationship is drawn on a single-case basis to gain information on properties other than hardness, most often to obtain a good estimate of tensile strength. Special relationships are sometimes drawn for hardness-to-hardness conversions. This may be done as long as the following conditions are fulfilled.

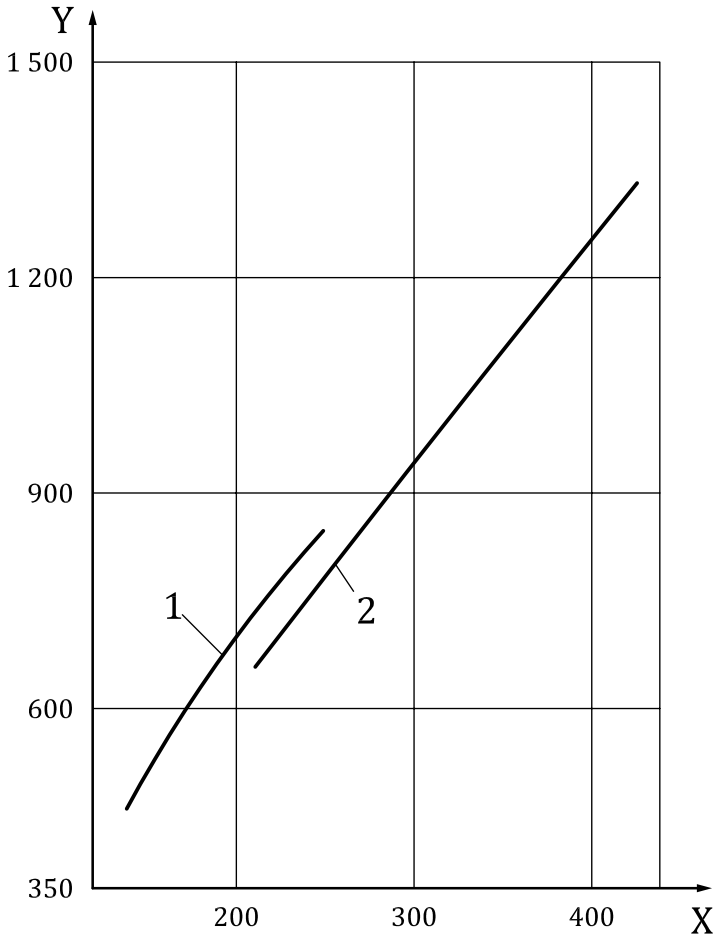
— The hardness test method used is only employed internally, and the results obtained will not be compared with those of other methods, or the details of the test procedure are defined precisely enough so that results can be reproduced by another laboratory or at another time.

— The conversion tables used shall have been derived from a sufficiently large number of parallel experiments using both scales and carried out on the material in question.

— Converted results are to be expressed in such a manner that it is clear which method was used to determine the original hardness value.

However, the conversion values in this International Standard are informative only. A measurement made according to the correct hardness (or tensile) standard for the scale being reported shall always take precedence over a hardness (or strength) value derived from a conversion table within this International Standard. Similarly, a value derived by conversion shall not provide sufficient grounds either for a complaint or for proof of meeting an acceptance criterion.

WARNING — In practice, an attempt is often made to establish a strong relationship between the original and converted values without taking the characteristics of the material under test into consideration. As Figures 1 and 2 show, this is not possible. Therefore, users of this International Standard should ensure that all conditions for conversion are met (see also References [2] and [3]).



Key

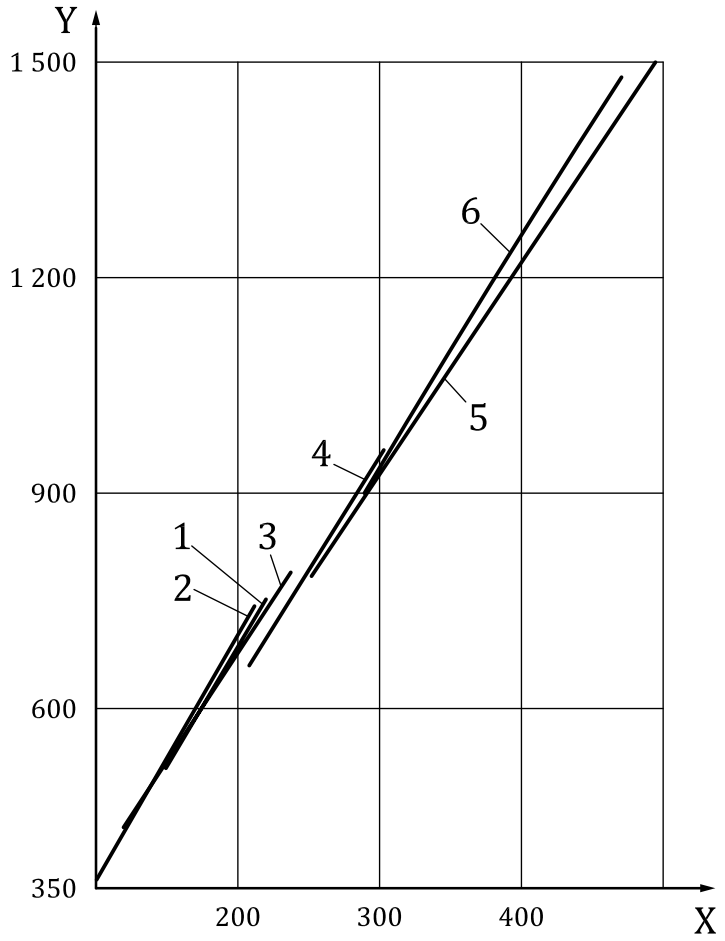
X Hardness HV 30

Y Tensile strength, R_m in MPa

1 untreated, soft annealed, normalized

2 quenched and tempered

Figure 1 — HV 30/R_m curves for quenching and tempering steels in various heat treatment conditions



Key

X	Hardness HV30	3	R_e/R_m=0,70 to 0,79 normal annealed
Y	Tensile strength, R_m in MPa	4	R_e/R_m=0,70 to 0,79 heat treated
1	R_e/R_m=0,45 to 0,59	5	R_e/R_m=0,80 to 0,89
2	R_e/R_m=0,60 to 0,69	6	R_e/R_m=0,90 to 0,99

Figure 2 — Mean HV 30/R_m curves for quenching and tempering steels with different R_e/R_m ratios

3 Application of conversion tables

3.1 General

Conversion from one hardness value to another or from a hardness value to a tensile strength value involves uncertainties which must be taken into account. Extensive investigations have shown that it is not possible to establish universally applicable conversion relationships between hardness values obtained by different methods, no matter how carefully the tests had been carried out. This lies in the fact that there is a complex relationship between the indentation behaviour of a material and its elastic and plastic deformation. For this reason, the given conversion relationship provides greater equivalency the more similarity there is between the elasticity of the tested material and that of the material used to establish the relationship. Likewise, a better equivalency can be expected for methods with similar indentation processes (i.e. where the differences in the force application-indentation procedures and the test parameters is minimal). Therefore, conversion from hardness values to tensile values must be seen as being the least reliable form of conversion.

NOTE In many cases, the yield strength or the 0,2 % proof strength provides information on the elastic behaviour of a material.

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