INTERNATIONAL STANDARD

ISO 4507

Second edition
2000-03-01

Sintered ferrous materials, carburized or carbonitrided — Determination and verification of case-hardening depth by a micro-hardness test

Matériaux ferreux frittés, cémentés ou carbonitrurés — Détermination et vérification de la profondeur de cémentation, par mesurage de la microdureté

Reference number
ISO 4507:2000(E)

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Printed in Switzerland

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4507 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 3, *Sampling and testing methods for sintered metal materials (excluding hardmetals)*.

This second edition cancels and replaces the first edition (ISO 4507:1978) which has been technically revised.

Sintered ferrous materials, carburized or carbonitrided — Determination and verification of case-hardening depth by a micro-hardness test

1 Scope

This International Standard specifies methods for determining the case-hardening depth of carburized or carbonitrided sintered ferrous materials by micro-hardness measurement.

The methods are adapted to materials having porosity and only apply to quenched materials.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2639, *Steel — Determination and verification of the effective depth of carburized and hardened cases.*

ISO 4498:—[1], *Sintered metal materials, excluding hardmetals — Determination of apparent hardness and micro-hardness.*

3 Term and definition

For the purposes of this International Standard, the following term and definition applies.

3.1
case-hardening depth
CHD
distance, measured normal to the surface of a case-hardened workpiece at a point at which the hardness corresponds to a specified limit

1) To be published. (Cancels and replaces ISO 4498-1:1990 and ISO 4498-2:1981)

4 Principle

Measuring of the micro-hardness by the Vickers testing method in accordance with ISO 4498:—, Procedure 2. It is measured on a section taken normal to the surface.

Drafting a curve representing hardness as a function of distance from the surface of the test piece. This allows a graphical determination of the case depth (method A).

Reading the case-hardening depth from this curve at the point corresponding to a specified hardness, usually 550 HV 0,1.

By agreement between the parties concerned, another value may be specified. In this case, the specified value is distinguished from the standard value by the symbol HG (given value).

In this International Standard the symbol HG is used to mean the specified hardness corresponding to the case depth, considering that 550 HV 0,1 is a particular value for it (it is the standard one).

The basic method A may be simplified for rapid spot checking (method B). In method B, the hardness is measured at two points situated at either side of the approximate case depth. The accurate case-hardening depth is then obtained by interpolation.

5 Apparatus

5.1 Vickers or Knoop micro-hardness testing machine, capable of applying a predetermined load of 0,980 7 N (HV 0,1) to an accuracy of ± 1 %.

5.2 Measuring instrument, capable of measuring the diagonals of the indentation to an accuracy of ± 0,5 μm.

6 Procedure

6.1 General

Micro-hardness measurements shall be made on a section of the sintered piece cut at right angles to the surface in an area chosen by agreement between supplier and user.

The test shall be made with a Vickers or Knoop diamond indentor.

The test load shall be 0,980 7 N (HV 0,1).

6.2 Preparation of sample

The surface on which the measurement is to be made shall be polished to a smoothness sufficient to permit correct measurements of the micro-hardness indentation. All precautions shall be taken to avoid damage to the edges of the specimen, overheating and changes of the surface due to smearing of the pores.

NOTE Preparation of the sample may be facilitated by impregnation with a thermosetting plastic.

6.3 Method A — Determination of case-hardening depth

6.3.1 Position of micro-hardness impressions

See Figure 1.

For each depth d_1, d_2, d_3, etc., make at least three indentations.

Discard the lowest individual hardness value if it is obviously too low (e.g. owing to porosity) or if by including this low value the hardness range of the other points is more than doubled. In all cases of a discarded value, make a replacement indentation.

Make indentations at depths d_1, d_2, d_3, etc. (measured in millimetres from the surface) as follows:

0,05; 0,1; 0,2; 0,3; 0,4; 0,5; 0,75; 1; 1,5; 2; 3 where d_1 = 0,05 etc.

The distance between two adjacent indentations, S, shall be not less than 2,5 times the diagonal of the impression.

Indentations shall be within a zone, perpendicular to the surface, of width W equal to 1,5 mm.

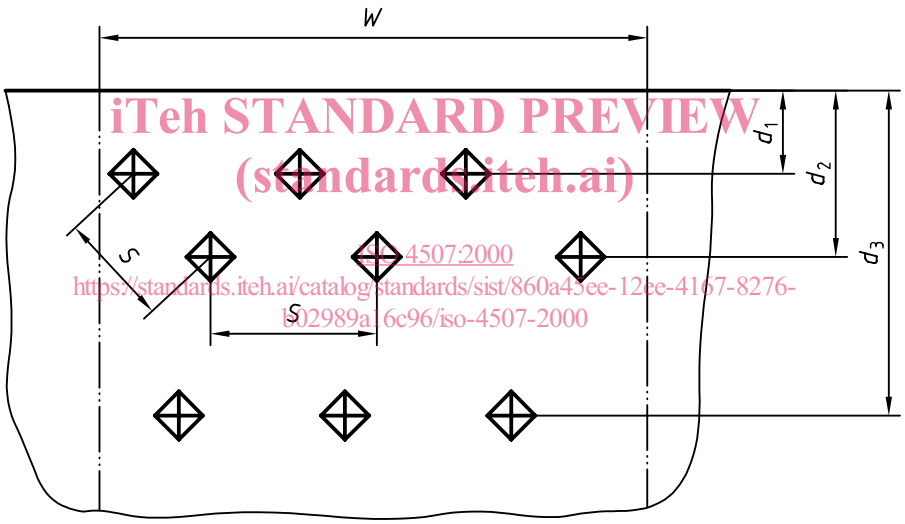

Figure 1 — Position of micro-hardness impressions

6.3.2 Evaluation

Calculate the arithmetic mean of the hardness values obtained at each depth and plot these mean values on a graph of hardness versus distance from the surface (see Figure 2). Draw the best fit through the plotted points.

Then draw the horizontal line at the ordinate HG corresponding to the specified value of hardness.

The case-hardening depth CHD is then given by the abscissa of the intercept of this line and the curve of variation of hardness.

The accuracy of the determination depends upon the number of indentations at each depth.

Extra indentations in the region of the approximate case depth will improve accuracy if the result is imprecise due to a small angle of intersection beween the curve and the horizontal line.

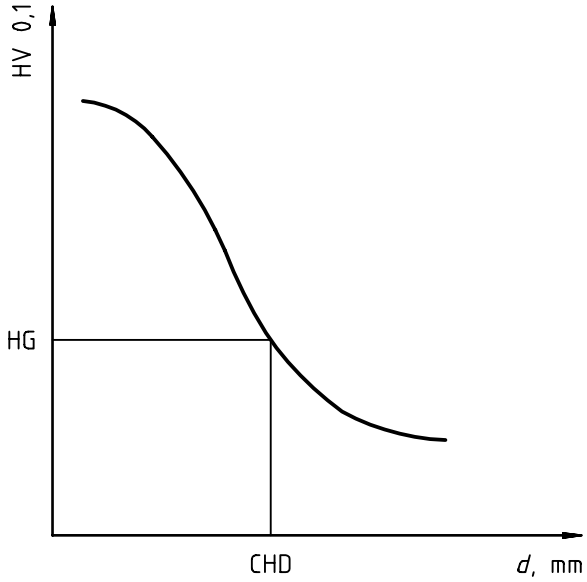

Figure 2 — Determination of case-hardening depth using method A

6.4 Method A modified — Determination of case-hardening depth

6.4.1 Position of micro-hardness impressions

When the microstructure and porosity conditions are such that it is impractical to take hardness readings at pre-selected depths, then it is permissible to simply plot individual hardness readings versus depth below surface.

6.4.2 Evaluation

Draw the best fit through the plotted points.

Draw a horizontal line at the ordinate, HG, corresponding to the specified value of hardness.

The case-hardening depth CHD is then given by the abscissa of the intercept of this line and the curve of variation of hardness.

6.5 Method B — Inspection test for case-hardening depth

6.5.1 General

It is assumed that the curve which represents the case depth as a function of hardness can be regarded as a straight line in the region of the case-hardening depth established by method A.

6.5.2 Position of micro-hardness impressions

Prepare the section in the same manner as for method A, but measure the micro-hardness at only two depths, d_1 and d_2, from the surface (see Figure 3).

Choose the depths d_1 and d_2 so that d_1 is less than the estimated case-hardening depth and d_2 is greater than the estimated case-hardening depth but less than the total case depth.

Choose d_1 and d_2 on the basis of past experience with similar materials or a previously plotted hardness curve, established on a similar material, as in method A. Make at least five micro-hardness impressions at each of the two depths.

The distances between adjacent impressions, and also the elimination of low values, shall be subject to the same rules as in method A.

If the hardnesses measured at depths d_1 and d_2 are both greater than or both less than that of the case-hardening depth, then method A shall be used to determine the case-hardening depth.

6.5.3 Evaluation

Calculate the arithmetic mean of the hardness values obtained at each depth. Then use one or the other of the two following methods.

a) Graphical method (see Figure 3)

Use a graph of hardness versus distance from the surface. Plot the two mean hardnesses $\overline{H}_1$ and $\overline{H}_2$ against the depths d_1 and d_2 respectively. Join the two points by a straight line.

The case-hardening depth CHD is given by the abscissa of the intercept of this line with a horizontal line drawn on the ordinate HG (corresponding to specified case hardness).

b) Calculation method

Calculate the case-hardening depth CHD using the formula

$$\mathrm{CHD} = d_1 + \frac{(d_2 - d_1)(\overline{H}_1 - \mathrm{HG})}{\overline{H}_1 - \overline{H}_2}$$

where

HG is the specified hardness;

$\overline{H}_1$ and $\overline{H}_2$ are the arithmetic means of the values of hardness measured at distances d_1 and d_2 (see Figure 3).

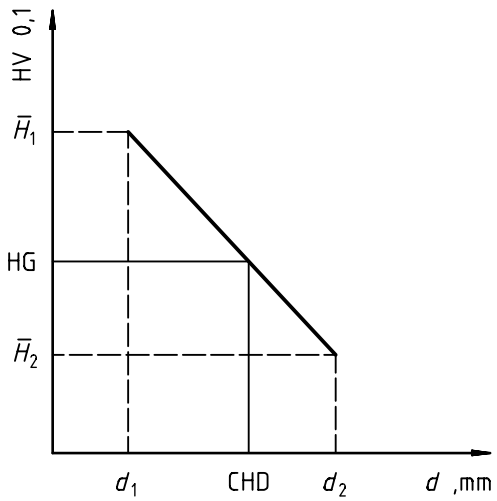

Figure 3 — Determination of case-hardening depth using method B