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Technical product documentation — Heat-treated ferrous parts — Presentation and indications

Documentation technique de produits — Produits ferreux traités thermiquement — Présentation et indications

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 15787 was prepared by Technical Committee ISO/TC 10, *Technical product documentation*, Subcommittee SC 6, *Mechanical engineering documentation*.

Annex A of this International Standard is for information only.

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Technical product documentation — Heat-treated ferrous parts — Presentation and indications

1 Scope

This International Standard specifies the manner of presenting and indicating the final condition of heat-treated ferrous parts in technical drawings.

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 128-24:1999, *Technical drawings — General principles of presentation — Part 24: Lines on mechanical engineering drawings*

ISO 2639—[1)], *Steels — Determination and verification of the depth of carburized and hardened cases*

ISO 4885, *Ferrous products — Heat treatments — Vocabulary*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1:1999, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

3 Terms, definitions and abbreviations

For the purposes of this International Standard, the terms and definitions given in ISO 4855 and the following abbreviations/symbols apply.

CHD Case hardening depth

CD Carburization depth

CLT Compound layer thickness

FHD Fusion hardness depth

1) To be published. (Revision of ISO 2639:1982)

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NHD Nitriding hardness depth

SHD Surface hardening depth

FTS Fusion treatment specification

HTO Heat-treatment order

HTS Heat-treatment specification

4 Indications in drawings

4.1 General

Indications in drawings concerning the heat-treatment condition can relate to the assembly or final condition as well as to the condition directly after heat-treatment. This difference has to be observed implicitly, as heat-treated parts are often subsequently machined (e.g. by grinding). By this, the hardness depth is reduced, especially with case hardened, surface hardened, surface fusion hardened and nitrided parts, as is the compound layer thickness of nitrocarburized parts. The machining allowance must therefore be taken into account appropriately during heat-treatment. If no separate drawing is made for the condition after heat-treatment giving relevant information on the condition *prior* to subsequent machining, suitable indications[2)] shall be used to illustrate to which condition the respective information in the drawing relates.

4.2 Material data

Regardless of the heat-treatment method, generally the drawing shall identify the material used for the heat-treated workpiece (name of the material, reference to the bill of materials etc.).

4.3 Heat-treatment condition

The condition after heat-treatment shall be specified in words indicating the required condition, for example, “quench hardened”, “quench hardened and tempered” or “nitrided”.

Where more than one heat-treatment is required, they shall each be identified in words in the sequence of their execution, for example, “quench hardened and tempered”. Indications by wording shall be chosen in accordance with ISO 4885. See clause 6 for particular, practical examples.

The heat-treatment condition can be achieved in different ways. As a result, the performance characteristics can differ. Particulars of the technical process shall be specified in supplementary documents where this is of importance for the heat-treatment condition.

4.4 Hardness data

4.4.1 Surface hardness

The surface hardness shall be indicated as Vickers hardness in accordance with ISO 6507-1, as Brinell hardness in accordance with ISO 6506-1 or as Rockwell hardness in accordance with ISO 6508-1. Additional hardness values shall be given in instances where the parts in the heat-treatment condition are to have surface areas of varying hardnesses (see clause 5).

See Tables A.1 to A.3 for specification of surface hardness. See Table A.4 for its relationship to limiting hardness.

2) This can be done, for example, by indicating the premachining dimensions (in brackets [ ]), by an additional representation, or by adding the words “before grinding” or “after grinding”.

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4.4.2 Core hardness

The core hardness shall be indicated in the drawing where necessary and a specification given that it is to be tested. The core hardness shall be given as Vickers hardness in accordance with ISO 6507-1, Brinell hardness in accordance with ISO 6506-1 or Rockwell hardness (methods B and C) in accordance with ISO 6508-1:1999.

NOTE Destruction of, or damage to, a workpiece is inevitable when testing. If necessary, testing can be carried out on a reference sample heat-treated together with the workpieces for this purpose.

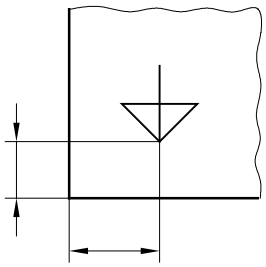
4.4.3 Hardness value

All hardness values shall be toleranced.

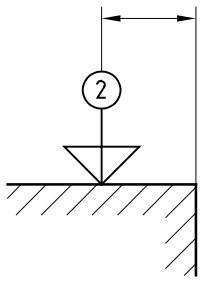
Tolerances should be as large as functionality permits.

4.5 Marking of measuring points

If it is necessary to mark the measuring point in the drawing, the symbol for the measuring point shall be indicated according to Figure 1, a). The symbol shall be directly combined with an identification number for the measuring point according to Figure 1, b), and its precise position shall be replaced (see, for example, Figures 2, 3 and 5).



a) General dimensioning of a measuring point



b) Dimensioning of measuring point 2

Figure 1

4.6 Hardness depth

The hardness depth shall be given as surface hardening depth (SHD), case hardening depth (CHD), fusion hardness depth (FHD) or nitriding hardness depth (NHD) according to the heat-treatment method. For recommended grading of values, see Tables A.5, A.6, A.7 and A.8.

Hardness depth values shall be toleranced. The deviations should be as large as functionally possible. For recommended values for the upper limit deviations, see Tables A.5, A.6, A.7 and A.8.

The core hardness shall be indicated in the drawing where necessary and a specification given that it is to be tested. The core hardness is given as Vickers hardness in accordance with ISO 6507-1, Brinell hardness in accordance with ISO 6506-1 or Rockwell hardness (methods B and C) in accordance with ISO 6508-1:1999.

NOTE Destruction of, or damage to, a workpiece is inevitable when testing. If necessary, testing can be carried out on a reference sample heat-treated together with the workpieces for this purpose.

4.7 Carburization depth (CD)

This is usually determined from the carbon content profile with the carbon content, expressed as percentage by mass as a limiting characteristic (cf. ISO 4885). The carbon content limit shall then be added as a suffix (subscript) to the symbol.

EXAMPLE A carbon content limit of 0,35 of carbon percentage by mass is indicated by $CD_{0,35}$

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For recommended grading of values, see Table A.9. The core hardness shall be entered in the drawing where it is necessary and specified that it shall be tested. The core hardness is given as Vickers hardness in accordance with ISO 6507-1, Brinell hardness in accordance with ISO 6506-1 or Rockwell hardness (methods B and C) in accordance with ISO 6508-1:1999.

NOTE Destruction of, or damage to, a workpiece is inevitable when testing. If necessary, testing can be carried out on a reference sample heat-treated together with the workpieces for this purpose.

The carborization depth shall be toleranced. For the purposes of this International Standard, the lower limit deviation shall be zero; for recommended values for the upper limit, see Table A.9.

Tolerances should be as large as functionality permits.

4.8 Compound layer thickness (CLT)

This is the thickness of the outer area of the nitrided layer (see also ISO 4885). It is usually determined by light-microscopy. For recommended grading of values, see Table A.10.

The CLT thickness shall be enclosed in allowed deviations. The deviations should be as large as functionally possible. For the purposes of this International Standard, the lower limit deviation shall be zero. For recommended values for the upper limit deviations, see Table A.10.

4.9 Strength data

Strength values, where used, shall be toleranced. If samples of the workpiece are required for testing, they are heat-treated at the same time as the workpiece; the location from which they are to be taken shall be indicated.

Indication of the core hardness is unnecessary in such instances. The strength values are to be enclosed in allowed deviations. The deviations should be as large as functionally possible. For the purposes of this International Standard, the lower limit deviation shall be zero.

Strength values should be indicated only where necessary.

4.10 Microstructure

If necessary, information on hardness and hardness depth may be supplemented by information on the microstructure of the heat-treated parts, for example, the maximum residual austenite portion.

NOTE For investigation of the microstructure, destruction of, or (at least) damage to, the workpiece is inevitable. It can be sufficient, however, to carry out investigation on a reference sample heat-treated together with the workpieces for this purpose.

5 Graphical representation

5.1 General

Graphical representation of heat-treatment requirements shall be as shown in Figures 2 to 39.

5.2 Heat-treatment of the entire part

5.2.1 Uniform requirements

The heat-treatment condition shall be specified in words indicating the required condition. For examples, see Figures 2 to 6, 20 to 25 and 34 to 37.

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5.2.2 Areas with varying requirements

If a workpiece is to have varying values in different areas, this shall be represented as follows.

The respective areas shall each be given a specific identity to indicate the treatment required and the extent of its application. The characteristic numbers shall be repeated below the information, in words and according to 4.3, together with the required values (see Figures 7, 14, 16, 17, 21, 26, 27 and 30). If appropriate, specified measuring points shall be marked according to 4.5.

5.3 Local heat-treatment

5.3.1 General

It should be considered in each instance whether it is practical to locally limit the heat-treatment, as this can mean additional expenditure compared with the treatment of the entire part.

The size of the transition between heat-treated and non-heat-treated areas depends on the method of heat-treatment, and the material and shape of the part to be treated. It is therefore appropriate to specify the dimensions and tolerances for the size and position of the areas to be heat-treated in agreement with the hardening shop.

Areas where heat-treatment is not required should be left unmarked.

5.3.2 Areas requiring heat-treatment

Those areas of a part that are to be heat-treated shall be marked in the graphical representation by a type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999, outside the body outlines of the part. For parts with rotational symmetry, it shall be sufficient to indicate one relevant surface line (the “generatrix”), if this is not misleading, for the purposes of simplification (e.g. Figure 10). If necessary, the size and position of these areas shall be specified by dimensions and tolerances.

The transition between heat-treated and non-heat-treated areas lies, in principle, outside the nominal size for the length of the heat-treated area.

5.3.3 Areas that may be heat-treated

Apart from those areas that must be heat-treated, information shall also be given on areas which may be heat-treated, as this can facilitate the execution of local heat-treatment and reduce distortion.

Areas which may be heat-treated shall be marked by a type 02.2.1 dashed wide line, in accordance with ISO 128-24:1999, outside the body outlines and, if necessary, shall be dimensioned. Indications of tolerance are generally not required for these areas (see Figures 9, 11 and 31).

5.3.4 Areas that may not be heat-treated

Areas where no heat-treatment is allowed, in the case of full-hardening or within the long-dashed dotted wide or dashed wide lines, shall be marked by a long-dashed double-dotted narrow line of type 05.1, in accordance with ISO 128-24:1999.

5.4 Drawings providing specific indication of heat-treatment

The instructions on heat-treatment may be made on a separate representation of a part. This representation may be incomplete and may be placed in any free area of the drawing. It shall be titled “Representation of heat-treatment”, (see Figure 17).

This is also applicable analogous to the surface layer fusion hardening drawing.

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6 Practical examples

6.1 General

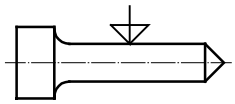
The figures and the associated instructions are practical examples. The suitability of the instruction to be given shall be determined on the basis of the technical details of the heat-treatment process.

Unless otherwise specified, all dimensions are in millimetres.

6.2 Quench hardening, quench hardening and tempering, austempering

6.2.1 Heat-treatment of the entire part — Allover uniform requirements

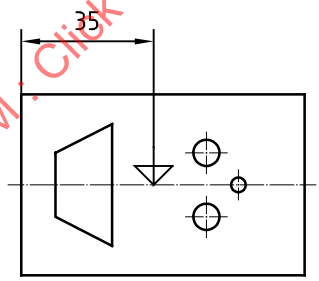
The quench hardened condition of the part illustrated by Figure 2 shall be designated by the wording "**quench hardened**" and by indicating the hardness value with the permissible deviation as well as by marking of the measuring point.



quench hardened
$\left(60^{+4}_{0}\right)$ HRC

Figure 2

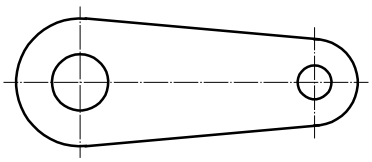
If tempering has to be carried out after hardening, "quench hardened" is not sufficient to designate the quench hardened *and* tempered condition unambiguously, and in such instances the full wording, "**quench hardened and tempered**", in accordance with 4.3 shall be given (see Figure 3).



quench hardened and tempered
$\left(59^{+4}_{0}\right)$ HRC

Figure 3

The part shown in Figure 4 is to be quench hardened and tempered. The designation shall read "**quench hardened and tempered**".



quench hardened and tempered
$\left(350^{+50}_{0}\right)$ HBW 2,5/187,5

Figure 4

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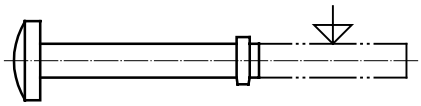
If a section of the heat-treated part is cut off in order to test the quench hardened and tempered state, marking shall be as shown in Figure 5.



quench hardened and tempered
$R_m = 1100\,^{+100}_{0}$ N/mm^2
$R_{p0,2} \geqslant 900$ N/mm^2
$A_5 \geqslant 9$ %

Figure 5

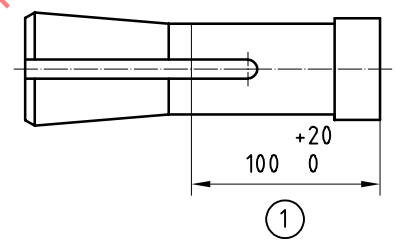
The part shown in Figure 6 is to be austempered. The designation shall read "**austempered**".

austempered
according to HTO
$\left(59\,^{+2}_{0}\right)$ HRC

Figure 6

6.2.2 Heat-treatment of the entire part — Areas with varying data

If a part is to have different hardness values for individual areas and heat-treatment is to be carried out in accordance with a heat-treatment order (HTO), the areas of different hardness shall be marked and, if necessary, dimensioned. In addition, reference shall be made to the HTO (see Figure 7).



quench hardened and tempered
according to HTO
$\left(58\,^{+4}_{0}\right)$ HRC
1 $\left(40\,^{+5}_{0}\right)$ HRC

Figure 7

6.2.3 Local heat-treatment

The part shown in Figure 8 is to be locally heat-treated. The heat-treated area shall be marked by a type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999, and with dimensional data according to 5.3. The test point shall be marked in accordance with 4.5.

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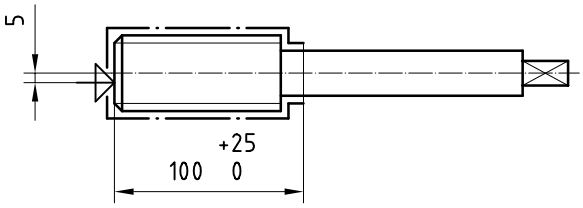
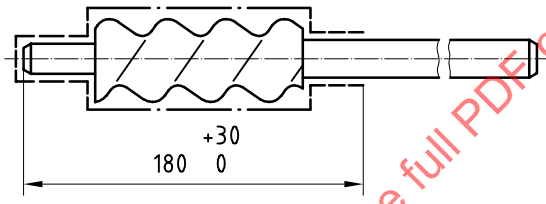


quench hardened and entire part tempered

$\left(60^{+3}_{0}\right)$ HRC

Figure 8

When heat-treating a workpiece, for reasons of processing it might be more convenient to harden a larger area than required. If this is done, the additionally quench hardened area shall be marked by a type 02.2.1 dashed wide line, in accordance with ISO 128-24:1999, and with dimensional data indicating the position of the heat-treated area (see Figure 9).



quench hardened and entire part tempered

$\left(61^{+3}_{0}\right)$ HRC

Figure 9

6.3 Surface hardening

6.3.1 General

Surface hardening is almost locally limited. Consequently, the requirements given in 5.3 shall be applicable.

6.3.2 Specification of surface hardness

When specifying the surface hardness of surface-hardened parts, a careful adaptation of the test load to SHD shall be observed. Selection of the test load shall be in accordance with Tables A.1 to A.3.

6.3.3 Specification of surface hardening depth (SHD)

To the symbol for the depth of hardening SHD shall be appended the numerical value for the limiting hardness, usually measured as Vickers hardness HV1. The limiting hardness is usually 80 % of the prescribed minimum surface hardness calculated in HV and can be taken from Table A.4, which also contains the limiting hardness for instances where the surface hardness is given in HRC, HRA or HRN.

The depth of hardening is given as a nominal dimension in millimetres. For recommended grading of SHD values and reference values for allocated minimum values, see Table A.5.

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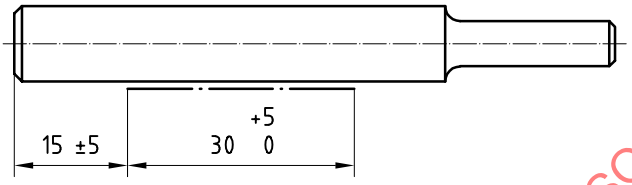
6.3.4 Practical examples

6.3.4.1 Generally applicable examples

In the simplest instance, a type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999, shall be sufficient for marking the surface-hardened area (see Figure 10), when keyed with the wording "**surface hardened**". The surface hardness and the surface hardening depth are characteristic for the surface hardened state.

The transition between the surface hardened and non-surface-hardened area lies, in principle, outside the nominal dimension for the length of the surface-hardened area. The transition width depends on the depth of hardening, the surface hardening method, and the material and shape of the workpiece.



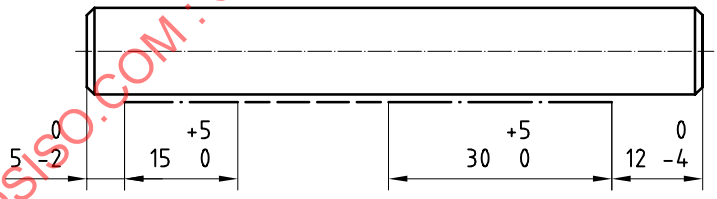
surface hardened

$\left(620\ ^{+160}_{0}\right)$ HV30

SHD 500 = $0{,}8\ ^{+0{,}8}_{0}$

Figure 10

If a part is surface hardened, for reasons of processing it may be more convenient to harden a larger area than required. If this is done, the additionally hardened area shall be marked by a type 02.2.1 dashed wide line, in accordance with ISO 128-24:1999, together with dimensional data indicating the position of the surface-hardened area (see Figure 11).



surface hardened and entire part tempered

$\left(525\ ^{+100}_{0}\right)$ HV10

SHD 425 = $0{,}4\ ^{+0{,}4}_{0}$

Figure 11

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If, for surface hardening of a part as shown in Figure 12, it is not necessary that the hardened surface layer extend to the edge (of considerable value in reducing the danger of spalling at the edges), this shall be specified by appropriate dimensioning.

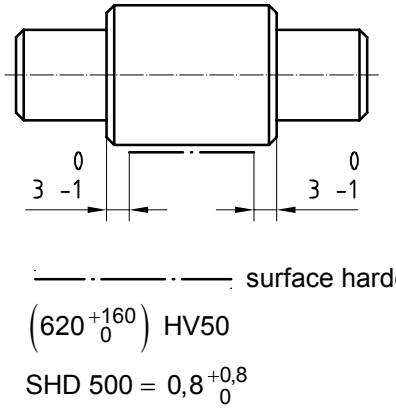

Figure 12

Where the surface layer extends to the edge, the configuration of the zone shall be indicated by a type 04.1 long-dashed dotted narrow line, in accordance with ISO 128-24:1999, within the workpiece outlines (as it is for the right-hand cam of the part shown in Figure 13). Where the hardened surface layer extends to the edge, it is permissible to have a lower SHD value directly adjacent to the edge (end of the hardened zone), and this shall also be indicated by the long-dashed dotted narrow line (see the left-hand cam in Figure 13).

NOTE In both instances, the edges are provided with a chamfer in order to reduce the danger of cracking.

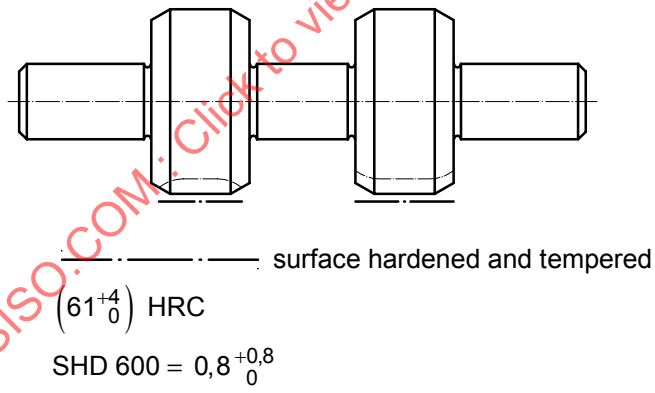

Figure 13

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6.3.4.2 Heat-treatment pictures for gears

6.3.4.2.1 General

Where the configuration and the position of the hardened surface layer is of importance for the performance characteristics (e.g. depth of transformation of the tooth flanks including the tooth bottom in respect of gears), this shall be indicated by a type 04.1 long-dashed dotted narrow line, in accordance with ISO 128-24:1999, within the workpiece outlines (see Figures 14, 15 and 16).

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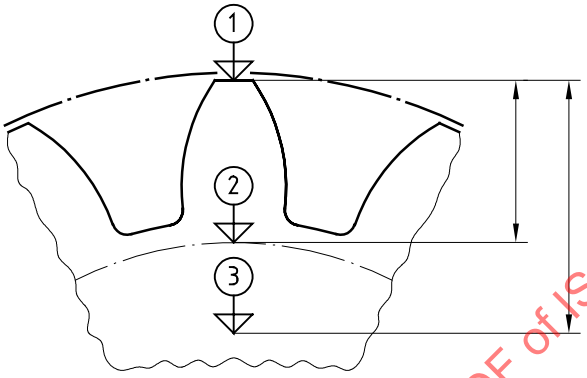
6.3.4.2.2 Full tooth hardening

A type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999, at the periphery of the gear and a type 04.1 long-dashed dotted narrow line, in accordance with ISO 128-24:1999, shall be used to show that the teeth are to be hardened in an area (see Figure 14).

NOTE Depending on the nature of the process, different hardness values will occur over the tooth height.

Indication of the measuring point makes it unnecessary to indicate the depth of hardening.



——·——·—— surface hardened and entire part tempered

① $\left(54^{+6}_{0}\right)$ HRC

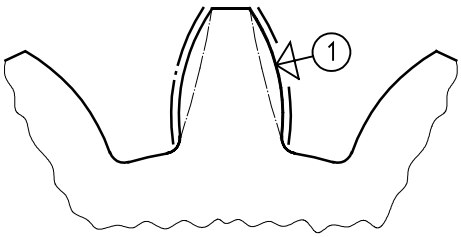
② $\left(50^{+4}_{0}\right)$ HRC

③ $\leqslant$ 30 HRC

Figure 14

6.3.4.2.3 Tooth flank surface hardening

A type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999, outside the body outlines shall be used to mark the surface-hardened area. A type 04.1 long-dashed dotted narrow line, in accordance with ISO 128-24:1999, shall be used to set off its position and configuration (see Figure 15). Because of the required configuration of the hardened layer, measuring points for the surface hardening depth shall be defined.



——·——·—— surface hardened and entire part tempered

① $\left(55^{+6}_{0}\right)$ HRC

SHD 475 = 1^{+1}_{0}

Figure 15

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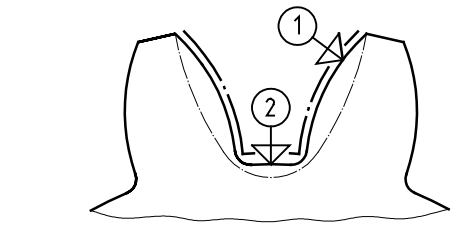
6.3.4.2.4 Tooth bottom surface hardening

A type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999, outside the body edges shall be used to mark the surface-hardened area, and a type 04.1 long-dashed dotted narrow line, in accordance with ISO 128-24:1999, shall be used to mark its position and configuration. Because of the configuration of the hardened surface layer, measuring points for the depth of hardening shall be defined (see Figure 16).



surface hardened and entire part tempered

$\left(52^{+6}_{0}\right)$ HRC

① SHD 425 = $1{,}6^{+1{,}3}_{0}$

② SHD 425 = 1^{+1}_{0}

Figure 16

6.3.4.3 Differing surface hardening depths

In the individual areas of the part shown in Figure 17, differing values are required for the depth of hardening. In addition, dimensioning of the hardened zones is necessary. But these additional indications make the representation of the part unclear. For this reason, heat-treatment drawings have been included for details Y and Z. A type 04.1 long-dashed dotted narrow line, in accordance with ISO 128-24:1999, shall be used to indicate the configuration of the hardened surface layer. The size and position shall be specified by dimensioning.

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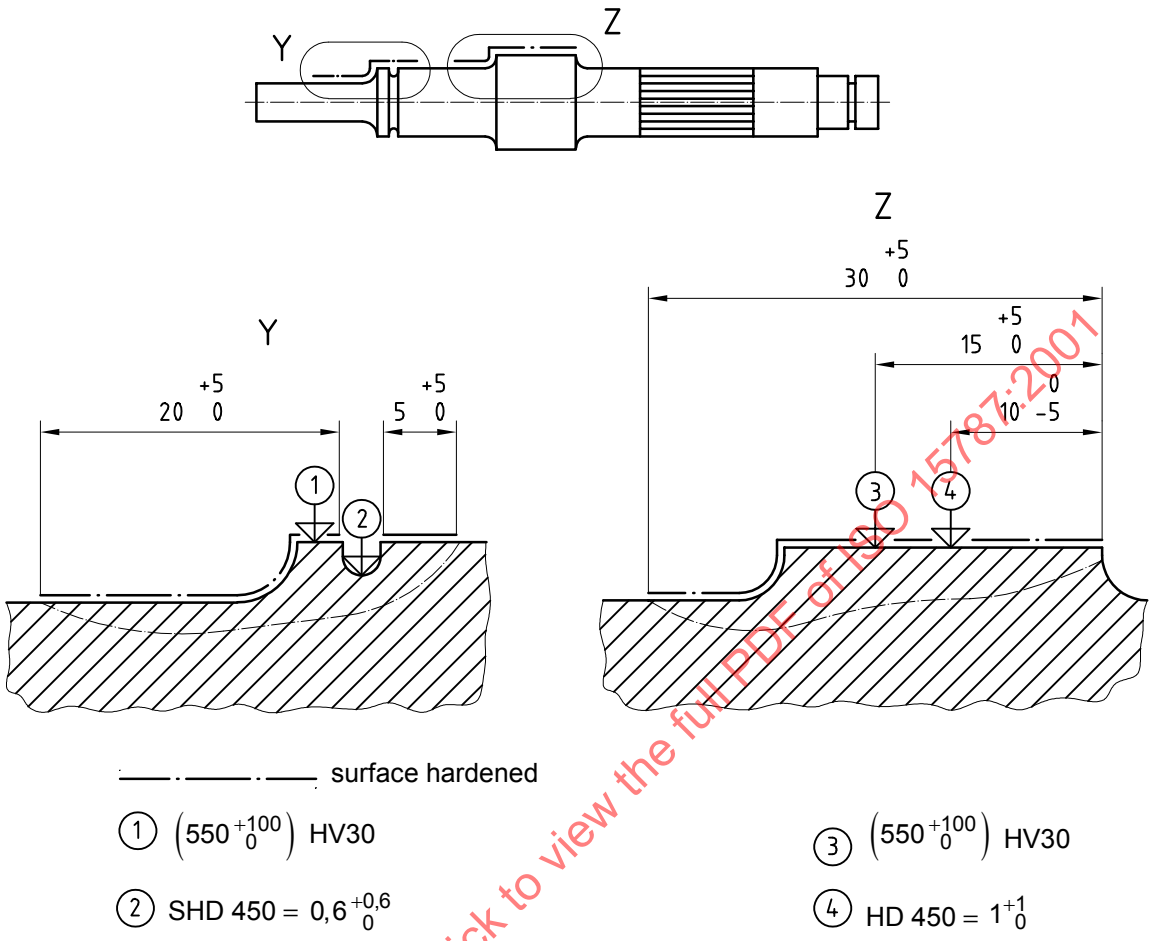
Representation of heat treatment



surface hardened

① $\left(550^{+100}_{0}\right)$ HV30

② SHD 450 = $0{,}6^{+0{,}6}_{0}$

③ $\left(550^{+100}_{0}\right)$ HV30

④ HD 450 = 1^{+1}_{0}

Figure 17

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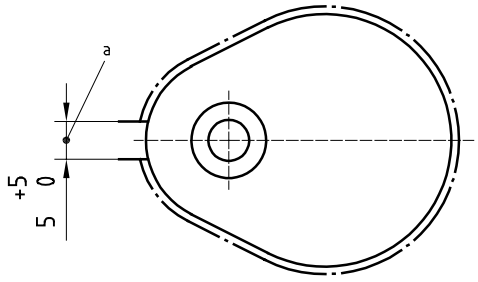
6.3.4.4 Surface hardening treatment with slip zone

When a part is surface-hardened, a slip zone can occur due to the nature of the process. The permissible position of the slip zone shall be defined by dimensioning (see Figure 18). Additional data shall be given in a HTS to which reference shall be made.



surface hardened according to HTS

$\left(48^{+4}_{0}\right)$ HRC

SHD 400 = $1{,}3^{+1{,}1}_{0}$

a Slip zone

Figure 18

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6.3.4.5 Example with more than one measuring point

The surface-hardened part (see Figure 19) shall have the given values in areas marked by type 04.2.1 long-dashed dotted wide lines, in accordance with ISO 128-24:1999, and by dimensioning (the process can be achieved by, for example, local tempering).

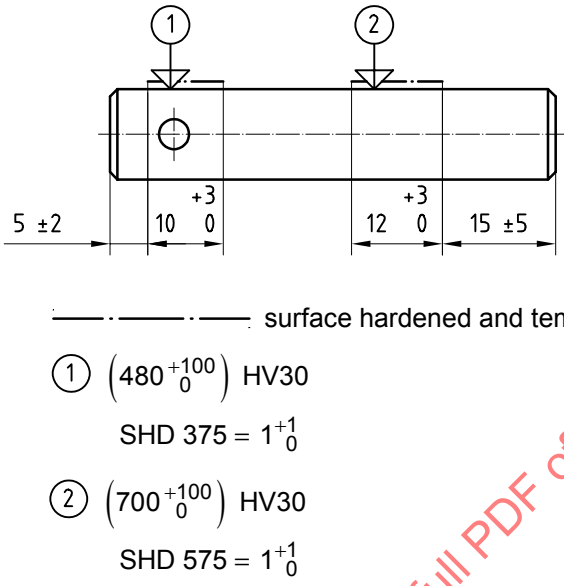

Figure 19

6.4 Surface fusion hardening

6.4.1 General

Surface fusion hardening is almost locally limited. Consequently, the requirements given in 5.3 shall be applied.

6.4.2 Specification of surface hardness

When specifying the surface hardness of surface fusion hardened parts, a careful adaptation of the test load to the FHD shall be observed. Selection of the test load shall be in accordance with Table A.1.

6.4.3 Specification of fusion hardness depth (FHD)

To the symbol for the depth of hardening consists FHD shall be appended the numerical value for the limiting hardness, usually measured as Vickers hardness HV1. The limiting hardness is usually 80 % of the prescribed minimum surface hardness calculated in HV and can be taken from Table A.4, which also contains the limiting hardness for instances where the surface hardness is given in HRC, HRA or HRN.

The fusion hardness depth is given as a nominal dimension in millimetres. For recommended grading of FHD values and reference values for associated minimum tolerances, see Table A.8.

6.4.4 Practical examples

6.4.4.1 Generally applicable examples

Marking of the surface fusion hardened area is done in the same manner as for surface hardening treatment (see 6.3). In the simplest instance, a type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999, shall be sufficient for marking the surface-hardened area (see Figure 10), when keyed with the wording “**surface**

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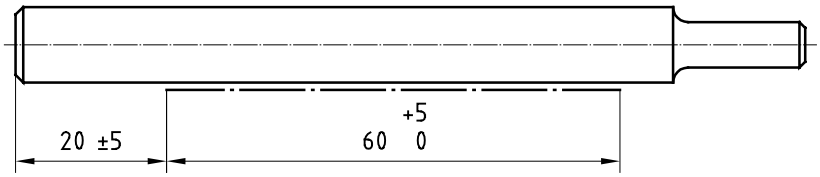
fusion hardened", together with the indication of the surface hardness and the fusion hardening depth (see Figure 20).



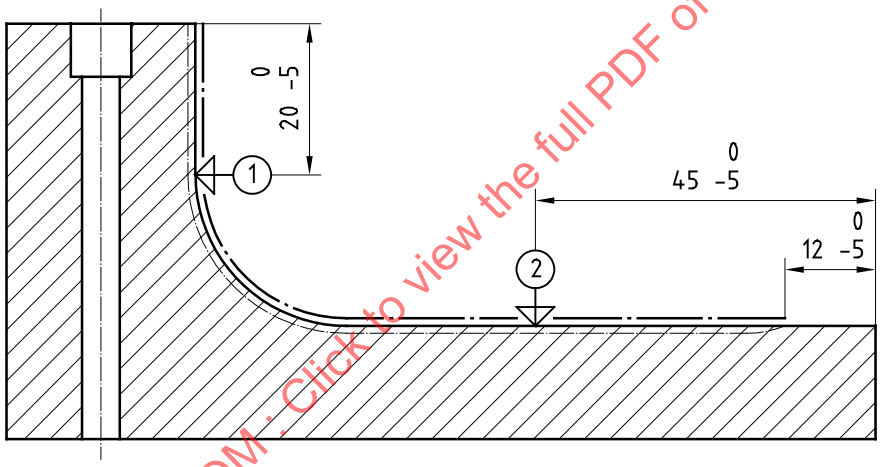
surface fusion hardened

$\left(620^{+160}_{0}\right)$ HV10

FHD 500 = $0{,}6^{+0{,}6}_{0}$

Figure 20

Figure 21 shows an example for varying fusion depths within the surface fusion-hardened area, and dimensioning of the defined measuring points.



surface fusion hardened

① $\left(650^{+100}_{0}\right)$ HV10

FHD = $1^{+0{,}5}_{0}$

② $\left(650^{+100}_{0}\right)$ HV10

FHD = $0{,}8^{+0{,}4}_{0}$

Figure 21

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6.4.4.2 Surface fusion hardening treatment with slip zone

Owing to the nature of the process, a slip zone can occur with surface fusion hardening treatment of a workpiece. The permissible position of the slip zone shall be defined by dimensioning (see Figure 22). Additional information shall be given in a fusion treatment specification (FTS) to which reference shall be made.

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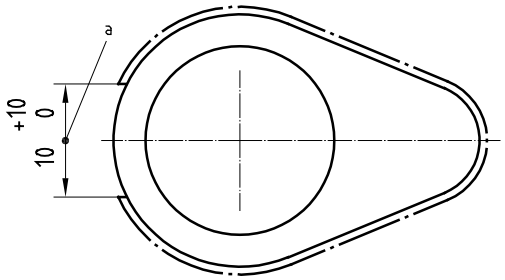

surface fusion hardened according to FTS

$\left(58\,^{+3}_{0}\right)$ HRC

FHD 525 = $0{,}8\,^{+0{,}8}_{0}$

a Slip zone

Figure 22

6.5 Case hardening

6.5.1 Specification of surface hardness

When specifying the surface hardness of case-hardened parts, a careful adaptation of the test load to CHD shall be observed. Selection of the test load shall be in accordance with Tables A.1, A.2 and A.3.

6.5.2 Specification of case hardening depth (CHD)

The symbol CHD shall be used. The limiting hardness is usually 550 HV1.

Case hardening depth is given as a nominal dimension in millimetres. For recommended grading of CHD values and reference values for associated minimum tolerances, see Table A.6.

6.5.3 Specification of carburization depth (CD)

Specification of carburization depth is required in instances where quench-hardening treatment is not carried out immediately after carburizing, for example, for the purpose of intermediate machining or levelling.

To the symbol CD used for the carburization depth shall be appended a suffix designating the limiting characteristic specified for the determination of the carburization depth[3)].

The carburization depth is given as a nominal dimension in millimetres. For recommended grading of CD values and reference values for associated minimum tolerances, see Table A.9.

6.5.4 Practical examples

6.5.4.1 Allover case hardening

Allover case hardening shall be indicated by the wording "**case hardened**" (see Figures 23 to 27).

In the simplest instance, marking shall be as shown in the example in Figure 23, indicating the heat-treatment condition, the surface hardness and the case hardening depth in each case, together with the permissible deviation (see Figure 23).

3) It is a general rule to use a carbon percentage by mass of 0,35 as a limiting characteristic. However, it is also permissible to specify other differing values.

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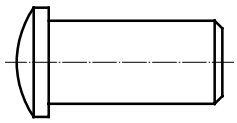


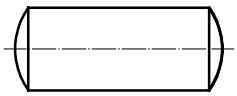
case hardened and tempered

$\left(60\,^{+4}_{0}\right)$ HRC

CHD = $0{,}8\,^{+0{,}4}_{0}$

Figure 23

If a limiting hardness or test load, or both, other than that or those specified in ISO 2639 is to be applied when testing the case hardening depth, this shall be indicated when specifying CHD (see Figure 24).



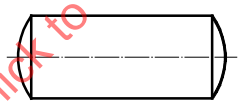
case hardened and tempered

$\left(700\,^{+100}_{0}\right)$ HV30

CHD 600 HV3 = $0{,}5\,^{+0{,}3}_{0}$

Figure 24

If specific provisions must be observed during heat-treatment (e.g. in respect of the data of the time/temperature curve), these provisions shall be taken from the heat-treatment order (HTO) or the heat-treatment specification (HTS). A reference shall be made to that document in the drawing (see Figure 25).



case hardened and tempered according to HTO

$\left(700\,^{+100}_{0}\right)$ HV30

CHD 600 HV3 = $0{,}5\,^{+0{,}3}_{0}$

Figure 25

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6.5.4.2 Allover case hardening with differing surface hardness or effective case depth after carburizing

6.5.4.2.1 General

Allover case-hardened parts with areas in which the values for the surface- or the case hardening depth, or both, differ from the rest of the area shall be marked as shown in Figures 26 and 27.

6.5.4.2.2 Differing surface hardness

The part shown in Figure 26 shall have the given hardness values in the area identified as the measuring point. The area for which a hardness value $\leqslant$ 550 HV10 is given shall, if possible, also be tempered.

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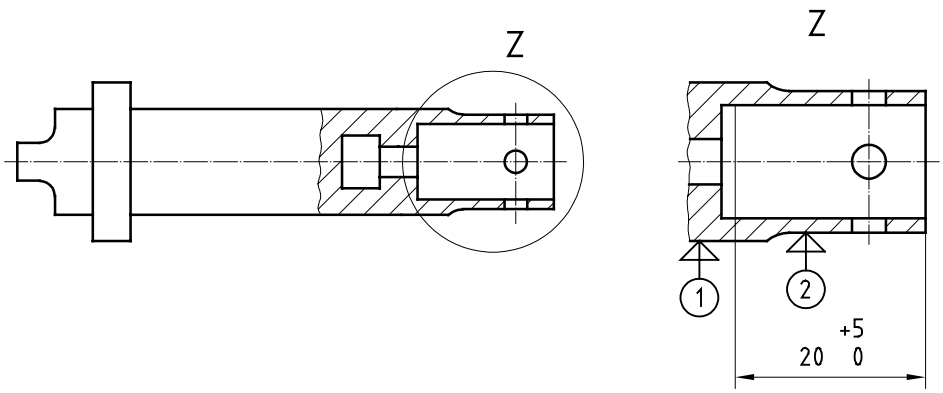


case hardened and tempered

① CHD = $0,3^{+0,2}_{0}$

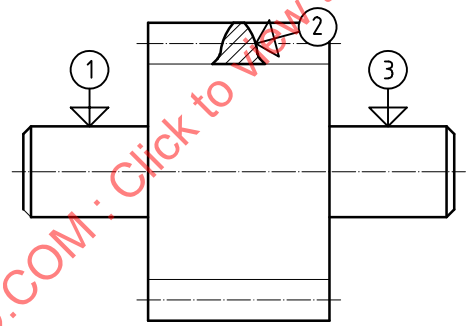
② $\left(700^{+100}_{0}\right)$ HV10

⩽ 550 HV10

Figure 26

6.5.4.2.3 Differing case hardening depth

The gear shown in Figure 27 is allover case-hardened. In the area of measuring points, the respective values specified for surface hardness and effective case depth shall be present.



case hardened and tempered

① + ③ $\left(60^{+4}_{0}\right)$ HRC

CHD = $0,8^{+0,4}_{0}$

② $\left(700^{+100}_{0}\right)$ HV10

CHD = $0,5^{+0,3}_{0}$

Figure 27

6.5.4.3 Local case hardening

6.5.4.3.1 General

The marking of case-hardened and non-case-hardened areas shall be in accordance with 5.3.

The transition between case-hardened and non-case-hardened areas lies, in principle, outside the nominal dimension for the length of the case-hardened area. The transition width depends on the effective case depth after

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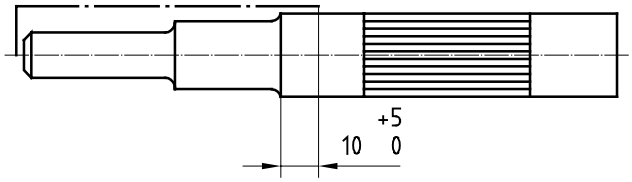
carburizing, the method of case hardening, the material, the shape of the workpiece and the way in which local case hardening is carried out.

6.5.4.3.2 Local case hardening with areas neither carburized nor hardened

The case-hardened area shall be marked, in accordance with ISO 128-24:1999, by a type 04.2.1 long-dashed dotted wide line (see Figure 28). The areas of the part outside the marking shall not be carburized or hardened.



case hardened and entire part tempered

$\left(680\ ^{+140}_{0}\right)$ HV10

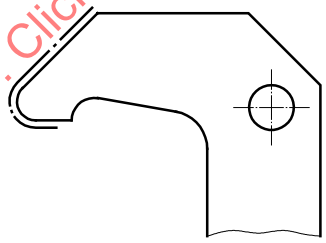
CHD = $0{,}3\ ^{+0{,}2}_{0}$

Figure 28

6.5.4.3.3 Local case hardening, part fully carburized

The case-hardened area shall be marked, in accordance with ISO 128-24:1999, by a type 04.2.1 long-dashed dotted wide line (see Figure 29). Outside this area, carburization is permitted and shall be indicated by the wording "**carburization of entire part permissible**".

NOTE This type of local case hardening is achieved by surface hardening after carburization in the area marked by the dashed dotted line.



case hardened and tempered

carburization of entire part permissible

$\left(60\ ^{+4}_{0}\right)$ HRC

CHD = $0{,}8\ ^{+0{,}4}_{0}$

Figure 29

6.5.4.3.4 Local case hardening with some areas hardened but not carburized

Where the representation is not clear, it is appropriate to indicate the values characterizing the case-hardened condition in a heat-treatment drawing (see Figure 30). The case-hardened area shall be marked by a type 04.2.1 long-dashed dotted wide line, in accordance with ISO 128-24:1999. The area not to be carburized but to be hardened lies outside the line. It is therefore a requirement that the wording "**entire part hardened**" be added.

NOTE This type of local case hardening is usually achieved by protecting the areas not marked with the dashed dotted line against carburization by a suitable method.

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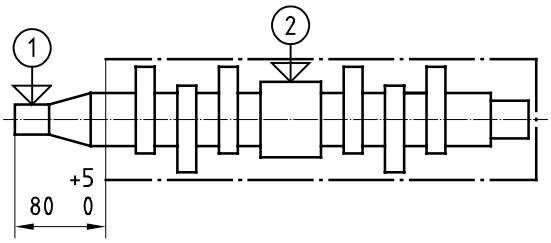


case hardened and entire part hardened and tempered

① $\left(25^{+15}_{0}\right)$ HRC

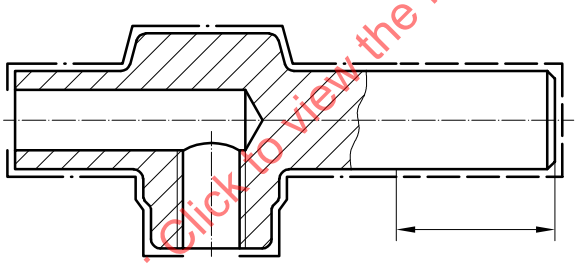
② $\left(58^{+4}_{0}\right)$ HRC

CHD = $1{,}2^{+0{,}5}_{0}$

Figure 30

6.5.4.3.5 Local case hardening with areas that may be case hardened

The area to be case hardened shall be marked, in accordance with ISO 128-24:1999, by a type 04.2.1 long-dashed dotted wide line (see Figure 31). The area within which case hardening is permitted shall be marked by a type 02.2.1 dashed wide line, which is more convenient for reasons of processing. The unmarked areas of the part (the holes in Figure 31) are not to be carburized or hardened.



case hardened and entire part tempered

$\left(57^{+6}_{0}\right)$ HRC

CHD = $1{,}2^{+0{,}5}_{0}$

Figure 31

6.5.4.4 Examples for carburized parts

6.5.4.4.1 Allover carburization

Allover carburization shall be indicated by the wording “**carburized**” (see Figure 32).

In the simplest case, marking of the carburized condition shall be with the wording “**carburized**” and by indicating the carburization with the permissible deviation (see Figure 32).

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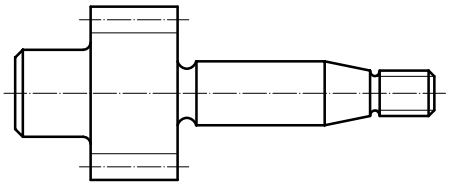

carburized

$CD_{0,35} = 1{,}2^{+0,5}_{0}$

Figure 32

6.5.4.4.2 Local carburization

The marking of the carburized and non-carburized areas shall be in accordance with 5.3.

The transition between carburized and non-carburized areas lies, in principle, outside the nominal dimension for the length of the carburized area. The transition width depends on the carburization depth, the carburizing method, the material and shape of the workpiece, and the way in which local carburization is carried out (see Figure 33).

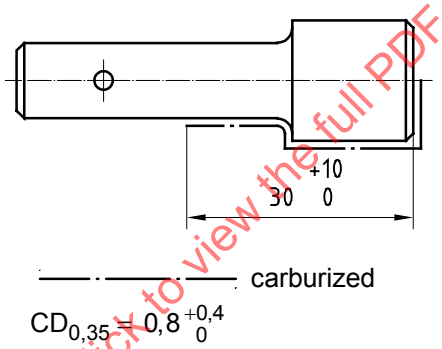

Figure 33

6.6 Nitriding and nitrocarburizing

6.6.1 Specification of surface hardness

When specifying the surface hardness of nitrided parts, a careful adaptation of the test load to the nitriding hardness depth NHD shall be observed. Selection of the test load shall be in accordance with Table A.1.

6.6.2 Specification of nitriding hardness depth (NHD)

The symbol NHD shall be used. The limiting hardness is usually 50 HV0,5 added to the actual core hardness.

The nitriding hardness depth is given as a nominal dimension in millimetres. For recommended grading of NHD values and reference values for associated minimum tolerances, see Table A.7.

6.6.3 Specification of compound layer thickness (CLT)

The thickness of the compound layer (CLT) and the limit deviation are given in micrometres. For recommended values of nominal dimensions and limit deviations, see Table A.10.

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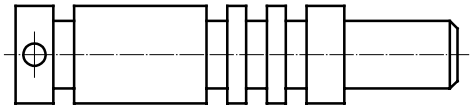
6.6.4 Practical examples

6.6.4.1 Allover nitriding

In its simplest instance, the nitrided condition shall be designated by the word "**nitrided**" and by indicating the nitriding hardness depth with the permissible deviation (see Figure 34).

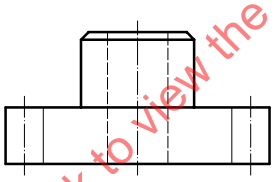
If the nitriding is to be carried out in gas or plasma, the wording shall be supplemented in accordance with ISO 4885, as shown, for example, in Figure 34.



plasma nitrided
$\geqslant$ 950 HV10
NHD = $0{,}3^{+0{,}1}_{0}$

Figure 34

When testing of the nitriding hardness depth is carried out in a way other than is as a rule specified and, for example, a test load other than HV0,5 is used, this shall be indicated when specifying NHD, as shown in the example of Figure 35.

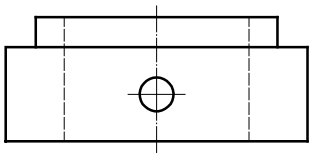


nitrided
$\geqslant$ 800 HV3
NHD HV0,3 = $0{,}1^{+0{,}05}_{0}$

Figure 35

6.6.4.2 Allover nitrocarburizing

In its simplest instance, the nitrocarburized condition shall be indicated by the word "**nitrocarburized**" and by indicating the compound layer thickness (CLT) with its limit deviation in micrometres (see Figure 36).



nitrocarburized
CLT = $\left(12^{+6}_{0}\right)$ µm

Figure 36

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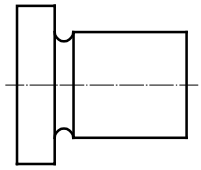
If nitrocarburizing was carried out in a specific medium, the wording of the indication of the process shall be supplemented accordingly (see ISO 4885). If necessary, reference shall be made to additional information (see Figure 37).



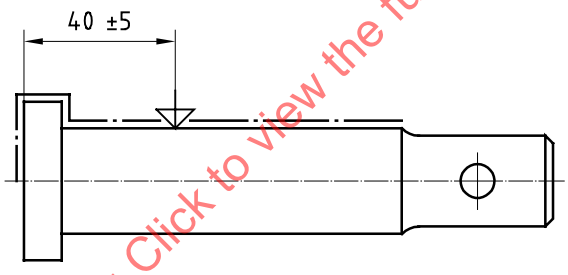
salt bath nitrocarburized
according to HTO
CLT = $\left(10^{+5}_{0}\right)$ µm

Figure 37

6.6.4.3 Local nitriding

Marking of the nitrided and non-nitrided areas shall be in accordance with clause 5.3.

The transition between nitrided and non-nitrided areas lies, in principle, outside the nominal dimension for the length of the nitrided area. The transition width depends on the nitriding depth and method, the material and shape of the workpiece, and the way in which local nitriding is carried out (see Figure 38).



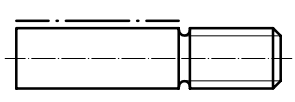
nitrided
⩾ 900 HV10
NHD = $0,4^{+0,2}_{0}$

Figure 38

6.6.4.4 Local nitrocarburizing

Marking of the nitrocarburized and non-nitrocarburized areas shall be in accordance with clause 5.3.

The transition between nitrocarburized and non-nitrocarburized areas lies, in principle, outside the nominal dimension for the length of the nitrocarburized area. The transition width depends on the thickness of the compound layer, the nitrocarburizing method, the material and shape of the workpiece, and the way in which local nitrocarburizing is carried out (see Figure 39).



nitrocarburized
CLT = $\left(15^{+8}_{0}\right)$ µm

Figure 39

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6.7 Annealing

The annealed-state condition shall be indicated by the word “**annealed**”, with an additional designation specifying the annealing method more precisely (see ISO 4885), as

— “stress relieved”,

— “soft annealed”,

— “spheroidized”,

— “recristallized”, or

— “normalized”.

In addition, hardness data or further data on the structural condition shall be given, as necessary.

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