UDC 669.14.018.26-42 : 669.14.018.298.3

October 1989

# Cold heading and cold extruding steels

## Technical delivery conditions for steels for quenching and tempering

DIN 1654 Part 4

Kaltstauch- und Kaltfließpreßstähle; technische Lieferbedingungen für Vergütungsstähle

Supersedes March 1980 edition.

*In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.*

The clauses and subclauses marked • give specifications which are to be agreed upon at the time of ordering, those marked •• give specifications which are optional and may be agreed at the time of ordering.

## 1 Field of application

This standard applies to steels for quenching and tempering with diameters from 2 mm to 100 mm, which should preferably be used for cold heading and cold extruding. It is to be used in conjunction with DIN 1654 Part 1.

## 2 Concepts

See DIN 1654 Part 1.

## 3 • Dimensions and limit deviations

See DIN 1654 Part 1.

## 4 Mass

See DIN 1654 Part 1.

## 5 Designation and ordering

See DIN 1654 Part 1.

## 6 Steel grades

See DIN 1654 Part 1.

## 7 Requirements

### 7.1 Manufacturing process

See DIN 1654 Part 1.

### 7.2 Treatment condition of material on delivery

The steel shall normally be supplied in one of the treatment conditions listed in table 1.

### 7.3 Chemical composition, mechanical properties and hardenability

Table 1 summarizes combinations of usual treatment conditions of the material on delivery, product forms and requirements regarding chemical composition, mechanical properties and hardenability.

•• Unless otherwise agreed, the requirements given in column 5 of table 1 shall apply for the relevant treatment condition of the material on delivery and for the particular product form.

•• For orders to requirement class H, which only applies to steels not containing boron (except for Cq 22 steel), the requirements regarding hardenability specified in table 6 shall also apply.

•• For orders to requirement class CH, the requirements regarding minimum hardness in the core and maximum diameter specified in table 8 shall apply in addition to those given in column 5 of table 1.

7.3.1 Table 2 shall apply for the chemical composition determined by ladle analysis.

7.3.2 The specifications given in table 3 shall apply for the limit deviations in the product analysis from the limiting values specified for the ladle analysis (see table 2).

7.3.3 The specifications given in table 4 shall apply for the mechanical properties in the usual treatment conditions of the material on delivery.

The values given in table 5 shall apply for the mechanical properties of reference test pieces and the ruling section after quenching and tempering.

7.3.4 The hardness values specified in table 6 may generally be assumed as applying to steel as covered in this standard under the test conditions specified in DIN 1654 Part 1.

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•• If the values specified in table 6 for the end quench test are to apply as a requirement, letter H shall be added to the material designation or material number for the steel when ordering.

7.3.4.1 •• Narrower hardenability bands may be agreed at the time of ordering, as specified in table 7 and footnotes 1 and 2 to table 6 and as shown in figures 1 c to 1 l. Where a narrower hardenability band with respect to the upper or lower limiting curve is required, symbol HH or HL shall be added to the material designation or material number for the steel when ordering.

7.3.5 The specifications given in table 8 shall apply for the core hardness and the maximum diameter.

### 7.4 Structure

See DIN 1654 Part 1.

### 7.5 Surface condition and soundness

See DIN 1654 Part 1.

### 7.6 Decarburization

See DIN 1654 Part 1.

### 7.7 Separation of products by casts

See DIN 1654 Part 1.

## 8 •• Testing

See DIN 1654 Part 1.

## 9 Marking

See DIN 1654 Part 1.

## 10 Heat treatment and further processing

10.1 The information given in clause 10 of DIN 1654 Part 1, October 1989 edition, shall be taken into account.

10.2 Table 9 specifies details of heat treatment.

## 11 Complaints

See DIN 1654 Part 1.

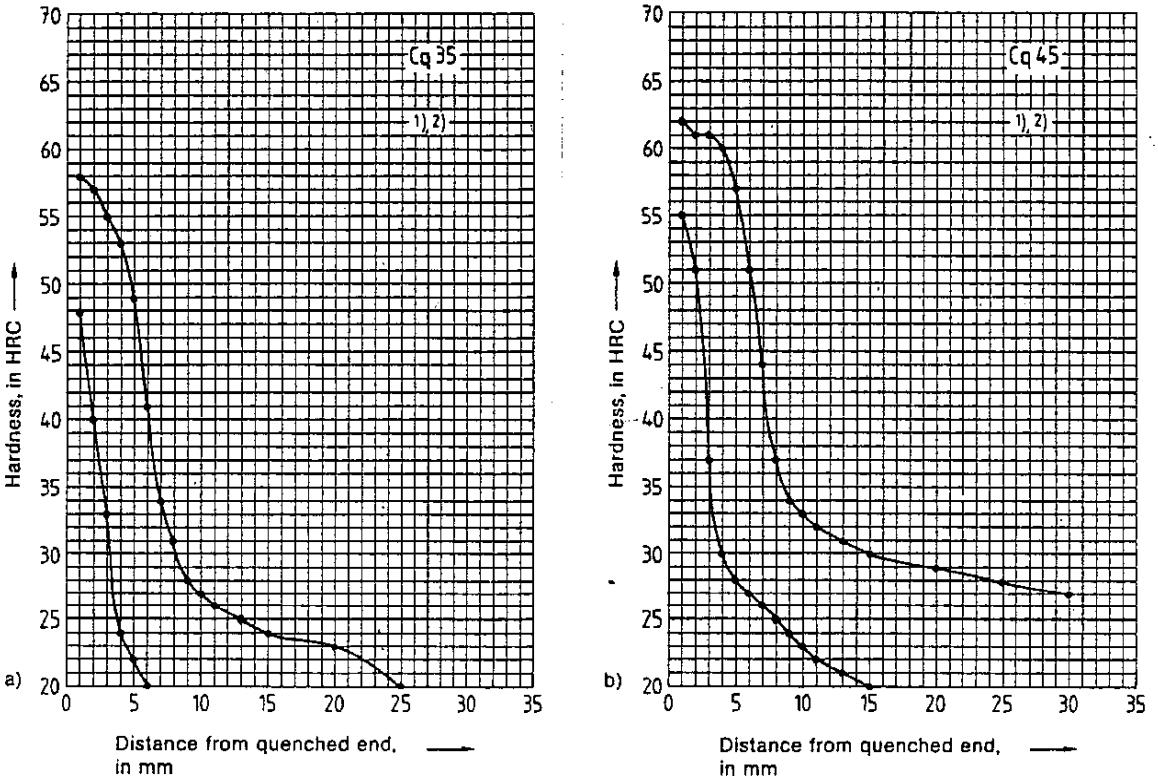
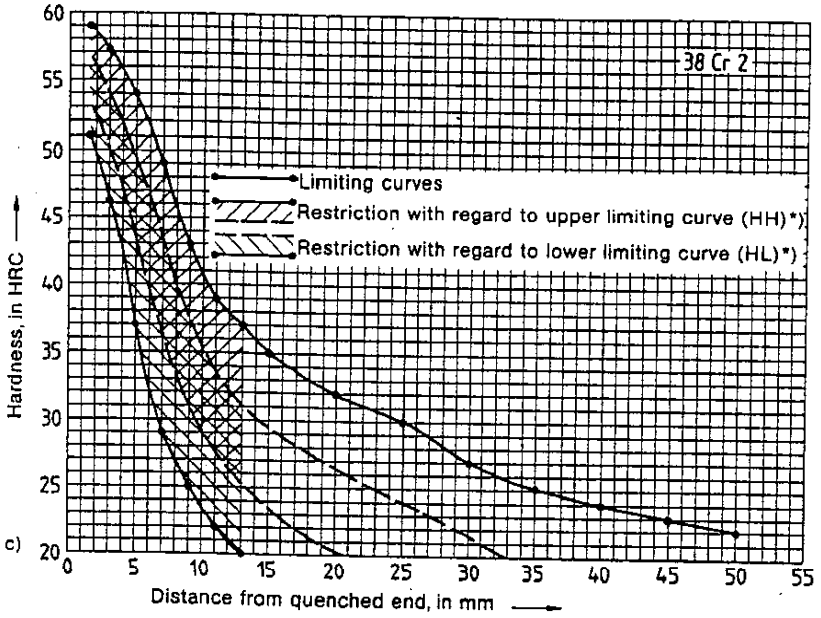



Figure 1. Hardenability bands for Rockwell C hardness determined in the end quench test (The curves shown in figures 1 a to 1 d are provisional.)

1) See table 7.

2) It should be noted that, when hardness test indentations are made at 1 mm intervals in this material at hardness values of less than 30 HRC, results will be affected by interaction between the indentations.




*) The restricted hardenability bands shall apply only up to the distance from the quenched end for which a hardness value is specified for the lower limiting curve; for greater distances, the restricted bands should be taken for guidance.

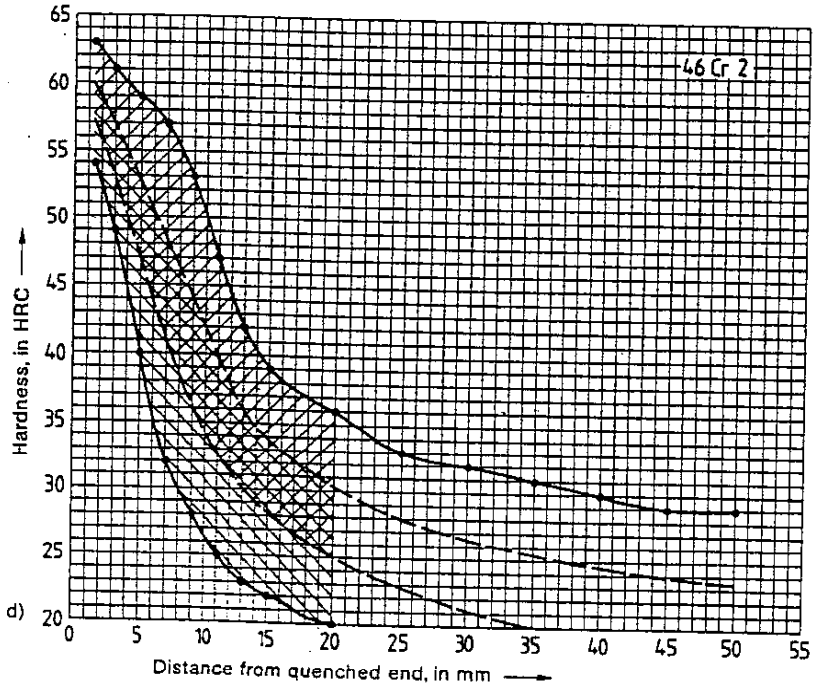



Figure 1 (continued).

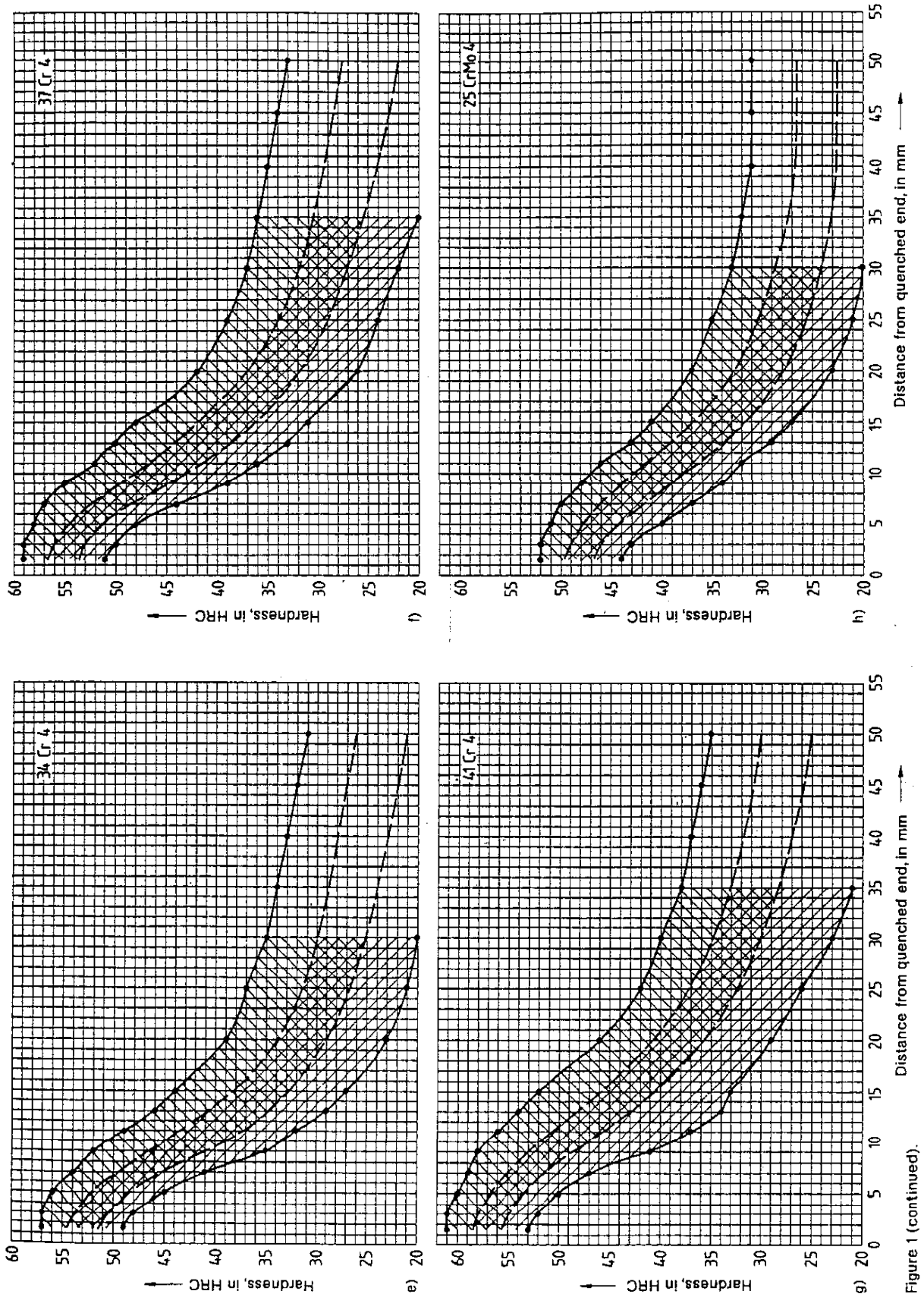



Figure 1 (continued).

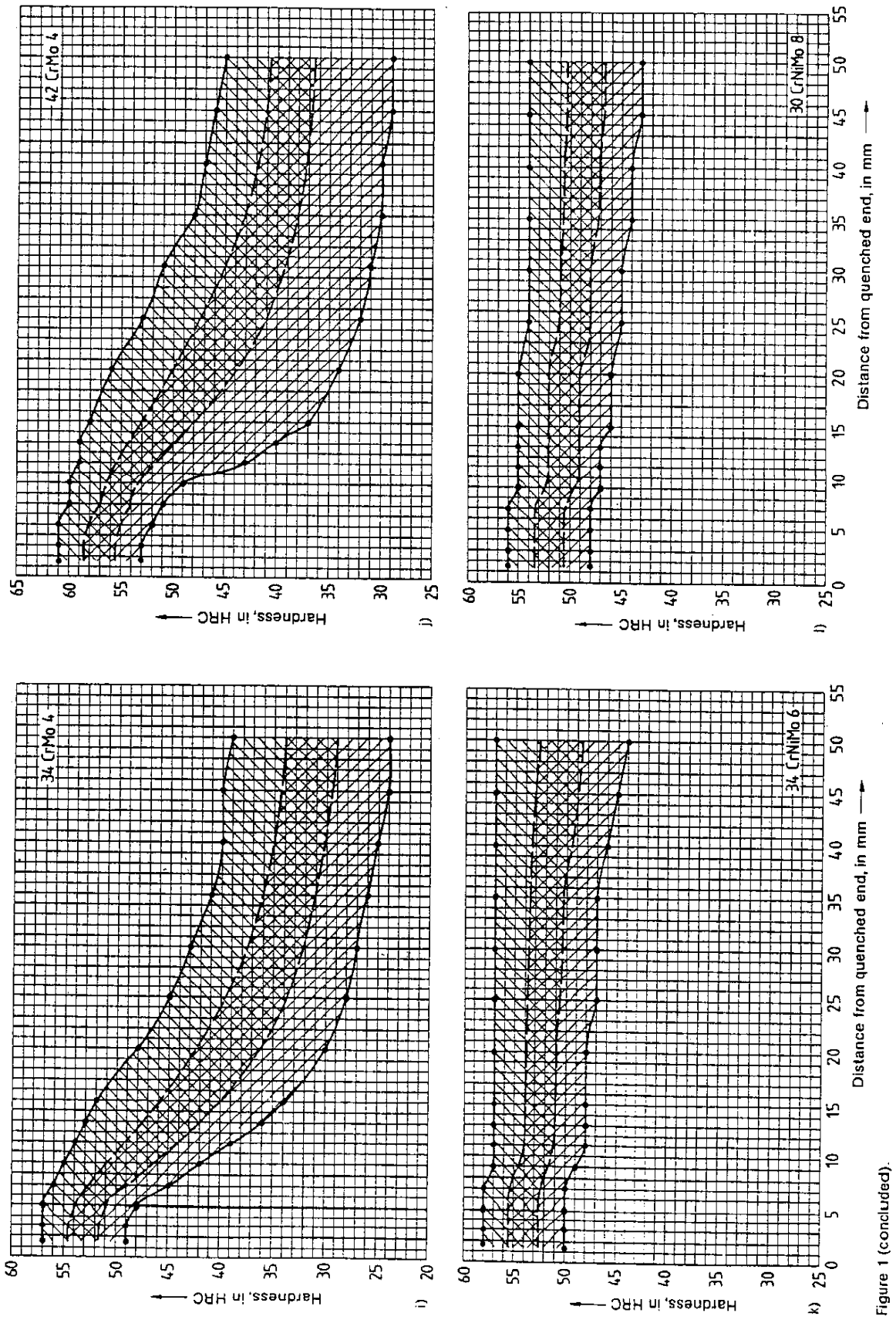



Figure 1 (concluded).

Table 1. **Treatment conditions and product forms in which steels are usually supplied and associated requirements as specified in tables 2 to 8**

| No. | 1 | | 2 | 3 | 4 | 5 | | | 6 | | | 7 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Treatment condition of material on delivery | | Product form | | | Requirement class | | | | | | | | |
| | | Symbol | Hot rolled steel bars | Wire rod | Drawn products | Unless otherwise agreed[1] | | | H[2] (see subclause 7.3.4) | | | CH[3] | | |
| | | | | | | 5.1 | 5.2 | | 6.1 | 6.2 | 6.3 | 7.1 | 7.2 | 7.3 |
| 2 | Untreated[4] | No symbol, or U | × | × | – | Chemical composition as in tables 2 and 3. | [5] | | As in columns 5.1 and 5.2. | | Hardenability as in table 6 or 7. | As in columns 5.1 and 5.2. | | Minimum hardness in the core and maximum diameter as in table 8. |
| 3 | Spheroidized | GKZ | × | × | – | | Mechanical properties as in table 4, | column 2[5] | | | | | | |
| 4 | Spheroidized and peeled | GKZ + SH | × | – | – | | | column 2[5] | | | | | | |
| 5 | Cold drawn and spheroidized | K + GKZ | – | – | × | | | column 3[5] | | | | | | |
| 6 | Cold drawn and spheroidized and slightly cold redrawn (with a reduction in cross section of 3 %, for example) | K + GKZ + K | – | – | × | | | column 4[5] | | | | | | |
| 7 | •• If a treatment condition other than those given in lines 2 to 6 is required, this shall be specified in uncoded form in the order; in such cases, the product form and the requirements shall be given in the order. | | | | | | | | | | | | | |

[1] The hardness values given in table 6 are to be regarded as guideline values in this case (see subclause 7.3.4).

[2] Letter H shall be given in the order.

[3] Symbol CH shall be given in the order.

[4] Applies mainly for steel supplied to drawing mills.

[5] The mechanical properties specified in table 5 for steel in the quenched and tempered condition shall be achievable after proper heat treatment.

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Table 2. **Chemical composition (ladle analysis)** [1], [2]

| Steel grade | | Percentage by mass | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Material designation | Material number | C | Si max. | Mn | P max. | S max. | Cr | Mo | Ni | B |
| **Steels free of boron** | | | | | | | | | | |
| Cq 22 | 1.1152 | 0,17 to 0,24 | 0,40 | 0,30 to 0,60 | 0,035 | 0,035 | – | – | – | – |
| Cq 35 | 1.1172 | 0,32 to 0,39 | 0,40 | 0,50 to 0,80 | 0,035 | 0,035 | – | – | – | – |
| Cq 45 | 1.1192 | 0,42 to 0,50 | 0,40 | 0,50 to 0,80 | 0,035 | 0,035 | – | – | – | – |
| 38 Cr 2 [3] | 1.7003 [3] | 0,35 to 0,42 | 0,40 | 0,50 to 0,80 | 0,035 | 0,035 | 0,40 to 0,60 | – | – | – |
| 46 Cr 2 [3] | 1.7006 [3] | 0,42 to 0,50 | 0,40 | 0,50 to 0,80 | 0,035 | 0,035 | 0,40 to 0,60 | – | – | – |
| 34 Cr 4 [3] | 1.7033 [3] | 0,30 to 0,37 | 0,40 | 0,60 to 0,90 | 0,035 | 0,035 | 0,90 to 1,20 | – | – | – |
| 37 Cr 4 [3] | 1.7034 [3] | 0,34 to 0,41 | 0,40 | 0,60 to 0,90 | 0,035 | 0,035 | 0,90 to 1,20 | – | – | – |
| 41 Cr 4 [3] | 1.7035 [3] | 0,38 to 0,45 | 0,40 | 0,60 to 0,90 | 0,035 | 0,035 | 0,90 to 1,20 | – | – | – |
| 25 CrMo 4 [3] | 1.7218 [3] | 0,22 to 0,29 | 0,40 | 0,60 to 0,90 | 0,035 | 0,035 | 0,90 to 1,20 | 0,15 to 0,30 | – | – |
| 34 CrMo 4 [3] | 1.7220 [3] | 0,30 to 0,37 | 0,40 | 0,60 to 0,90 | 0,035 | 0,035 | 0,90 to 1,20 | 0,15 to 0,30 | – | – |
| 42 CrMo 4 [3] | 1.7225 [3] | 0,38 to 0,45 | 0,40 | 0,60 to 0,90 | 0,035 | 0,035 | 0,90 to 1,20 | 0,15 to 0,30 | – | – |
| 34 CrNiMo 6 [3] | 1.6582 [3] | 0,30 to 0,38 | 0,40 | 0,40 to 0,70 | 0,035 | 0,035 | 1,40 to 1,70 | 0,15 to 0,30 | 1,40 to 1,70 | – |
| 30 CrNiMo 8 [3] | 1.6580 [3] | 0,26 to 0,34 | 0,40 | 0,30 to 0,60 | 0,035 | 0,035 | 1,80 to 2,20 | 0,30 to 0,50 | 1,80 to 2,20 | – |
| **Boron alloy steels** [4] | | | | | | | | | | |
| 22 B 2 | 1.5508 | 0,19 to 0,25 | 0,40 | 0,50 to 0,80 | 0,035 | 0,035 | – | – | – | 0,0008 to 0,0050 |
| 28 B 2 | 1.5510 | 0,25 to 0,32 | 0,40 | 0,50 to 0,80 | 0,035 | 0,035 | – | – | – | 0,0008 to 0,0050 |
| 35 B 2 | 1.5511 | 0,32 to 0,40 | 0,40 | 0,50 to 0,80 | 0,035 | 0,035 | – | – | – | 0,0008 to 0,0050 |
| 19 MnB 4 | 1.5523 | 0,17 to 0,24 | 0,40 | 0,80 to 1,15 | 0,035 | 0,035 | – | – | – | 0,0008 to 0,0050 |

[1] Elements not listed in this table shall not be deliberately added to the steel except for finishing the cast, without the purchaser's approval. In cases of doubt, the limits given in EN 10 020 shall apply.

[2] Except for phosphorus and sulfur, minor deviations from the limits specified for the ladle analysis are permitted if either restricted hardenability bands in the end quench test (see footnotes 1 and 2 to table 6) or quenched and tempered products have been ordered and, for this purpose, the values regarding the mechanical properties specified in table 5 are complied with. Any such deviations shall not be greater than the values given in table 3.

[3] The values for the chemical composition of this steel are identical with those given in DIN 17 200.

[4] The values given for this steel are provisional and may have to be corrected in the light of new findings.





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Table 3. **Amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified in table 2 for the ladle analysis**

| Element | Maximum permissible percentage by mass as determined by ladle analysis | Limit deviations in the product analysis from the limiting values specified for the ladle analysis [1], as a percentage by mass |
|---|---|---|
| C | ≤ 0,50 | 0,02 |
| Si | ≤ 0,40 | 0,03 |
| Mn | ≤ 1,00<br>> 1,00 ≤ 1,15 | 0,04<br>0,05 |
| P | ≤ 0,035 | 0,005 |
| S | ≤ 0,035 | 0,005 |
| Cr | ≤ 2,00<br>> 2,00 ≤ 2,20 | 0,05<br>0,10 |
| Mo | ≤ 0,30<br>> 0,30 ≤ 0,50 | 0,03<br>0,04 |
| Ni | > 1,00 ≤ 2,00<br>> 2,00 ≤ 2,20 | 0,05<br>0,07 |

[1] If a number of product analyses are to be carried out, the deviations shown by one element within one cast shall lie either only above the upper limit or below the lower limit of the range specified for the ladle analysis.

Table 4. **Mechanical properties[1]) of steel as specified in table 2, in the treatment condition in which they are usually supplied*)**

| 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|
| Steel grade | | Treatment condition[2]) | | | | | |
| | | GKZ or GKZ + SH | | K + GKZ | | K + GKZ + K | |
| Material designation | Material number | $R_m$ N/mm² max. | $Z$ % min. | $R_m$ N/mm² max. | $Z$ % min. | $R_m$ N/mm² max. | $Z$ % min. |
| Steels not containing boron | | | | | | | |
| Cq 22 | 1.1152 | 500 | 64 | 480 | 66 | 500 | 66 |
| Cq 35 | 1.1172 | 570 | 62 | 550 | 64 | 570 | 64 |
| Cq 45 | 1.1192 | 590 | 60 | 570 | 62 | 590 | 62 |
| 38 Cr 2 | 1.7003 | 600 | 60 | 580 | 62 | 600 | 62 |
| 46 Cr 2 | 1.7006 | 620 | 58 | 600 | 60 | 620 | 60 |
| 34 Cr 4 | 1.7033 | 600 | 60 | 580 | 62 | 600 | 62 |
| 37 Cr 4 | 1.7034 | 610 | 59 | 590 | 61 | 610 | 61 |
| 41 Cr 4 | 1.7035 | 620 | 58 | 600 | 60 | 620 | 60 |
| 25 CrMo 4 | 1.7218 | 580 | 60 | 560 | 62 | 580 | 62 |
| 34 CrMo 4 | 1.7220 | 610 | 59 | 590 | 61 | 610 | 61 |
| 42 CrMo 4 | 1.7225 | 630 | 58 | 610 | 60 | 630 | 60 |
| 34 CrNiMo 6 | 1.6582 | 680 | 58 | 660 | 60 | 680 | 60 |
| 30 CrNiMo 8 | 1.6580 | 700 | 58 | 680 | 60 | 700 | 60 |
| Boron alloy steels | | | | | | | |
| 22 B 2 | 1.5508 | 500 | 64 | 480 | 66 | 500 | 66 |
| 28 B 2 | 1.5510 | 540 | 62 | 520 | 64 | 540 | 64 |
| 35 B 2 | 1.5511 | 570 | 62 | 550 | 64 | 570 | 64 |
| 19 MnB 4 | 1.5523 | 520 | 62 | 500 | 64 | 520 | 62 |

*) The values are provisional and may have to be corrected in the light of new findings; this applies in particular to 34 CrNiMo 6 and 30 CrNiMo 8 steels.

[1]) $R_m$ is the tensile strength and $Z$ is the reduction in area after fracture.

[2]) See subclause 7.2.

Table 5. **Mechanical properties[1]) of steel in the quenched and tempered condition**
The diameter to be considered when applying this table shall correspond to the actual heat treated (i.e. quenched and tempered) cross section.

| Steel grade | | Diameter not exceeding 16 mm[2]), [3]), [4]) | | | | | |
|---|---|---|---|---|---|---|---|
| | | $R_e$ or $R_{p\,0,2}$ | $R_m$ | $A_5$ | $Z$ | Minimum impact value, $A_v$[5]) | |
| | | | | | | ISO U-notch test piece[6]) | ISO V-notch test piece[6]) |
| Material designation | Material number | N/mm² min. | N/mm² | % min. | % min. | J[7]) | |
| Cq 22 | 1.1152 | 350 | 550 to 700 | 20 | 50 | 39 | 50 |
| Cq 35 | 1.1172 | 430 | 630 to 780 | 17 | 40 | 29 | 35 |
| Cq 45 | 1.1192 | 500 | 700 to 850 | 14 | 35 | 20 | 25 |
| 38 Cr 2 | 1.7003 | 550 | 800 to 950 | 14 | 35 | 29 | 35 |
| 46 Cr 2 | 1.7006 | 650 | 900 to 1100 | 12 | 35 | 25 | 30 |
| 34 Cr 4 | 1.7033 | 700 | 900 to 1100 | 11 | 35 | 29 | 35 |
| 37 Cr 4 | 1.7034 | 750 | 950 to 1150 | 11 | 35 | 25 | 30 |
| 41 Cr 4 | 1.7035 | 800 | 1000 to 1200 | 10 | 30 | 25 | 30 |
| 25 CrMo 4 | 1.7218 | 700 | 900 to 1100 | 12 | 50 | 34 | 45 |
| 34 CrMo 4 | 1.7220 | 800 | 1000 to 1200 | 11 | 45 | 29 | 35 |
| 42 CrMo 4 | 1.7225 | 900 | 1100 to 1300 | 10 | 40 | 25 | 30 |
| 34 CrNiMo 6 | 1.6582 | 1000 | 1200 to 1400 | 9 | 40 | 29 | 35 |
| 30 CrNiMo 8 | 1.6580 | 1050 | 1250 to 1450 | 9 | 40 | 25 | 30 |
| Steel grade | | Diameter between greater than 16 and 40 mm[2]), [3]), [4]) | | | | | |
| | | $R_e$ or $R_{p\,0,2}$ | $R_m$ | $A_5$ | $Z$ | Minimum impact value, $A_v$[5]) | |
| | | | | | | ISO U-notch test piece[6]) | ISO V-notch test piece[6]) |
| Material designation | Material number | N/mm² min. | N/mm² | % min. | % min. | J[7]) | |
| Cq 22 | 1.1152 | 300 | 500 to 650 | 22 | 50 | 39 | 50 |
| Cq 35 | 1.1172 | 370 | 600 to 750 | 19 | 45 | 29 | 35 |
| Cq 45 | 1.1192 | 430 | 650 to 800 | 16 | 40 | 20 | 25 |
| 38 Cr 2 | 1.7003 | 450 | 700 to 850 | 15 | 40 | 29 | 35 |
| 46 Cr 2 | 1.7006 | 550 | 800 to 950 | 14 | 40 | 29 | 35 |
| 34 Cr 4 | 1.7033 | 590 | 800 to 950 | 14 | 40 | 34 | 40 |
| 37 Cr 4 | 1.7034 | 630 | 850 to 1000 | 13 | 40 | 29 | 35 |
| 41 Cr 4 | 1.7035 | 660 | 900 to 1100 | 12 | 35 | 29 | 35 |
| 25 CrMo 4 | 1.7218 | 600 | 800 to 950 | 14 | 55 | 39 | 50 |
| 34 CrMo 4 | 1.7220 | 650 | 900 to 1100 | 12 | 50 | 34 | 40 |
| 42 CrMo 4 | 1.7225 | 750 | 1000 to 1200 | 11 | 45 | 29 | 35 |
| 34 CrNiMo 6 | 1.6582 | 900 | 1100 to 1300 | 10 | 45 | 34 | 45 |
| 30 CrNiMo 8 | 1.6580 | 1050 | 1250 to 1450 | 9 | 40 | 25 | 30 |

For [1]) to [7]), see page 11.

Table 5 (concluded).

| Steel grade | | Diameter between greater than 40 and 100 mm[2], [3] | | | | | |
|---|---|---|---|---|---|---|---|
| | | $R_e$ or $R_{p\,0,2}$ | $R_m$ | $A_5$ | $Z$ | Minimum impact value, $A_v$[5] | |
| | | | | | | ISO U-notch test piece[6] | ISO V-notch test piece[6] |
| Material designation | Material number | N/mm² min. | N/mm² | % min. | % min. | J[7] | |
| **Cq 22** | **1.1152** | – | – | – | – | – | – |
| **Cq 35** | **1.1172** | 320 | 550 to 700 | 20 | 50 | 29 | 35 |
| **Cq 45** | **1.1192** | 370 | 630 to 780 | 17 | 45 | 20 | 25 |
| **38 Cr 2** | **1.7003** | 350 | 600 to 750 | 17 | 45 | 29 | 35 |
| **46 Cr 2** | **1.7006** | 400 | 650 to 800 | 15 | 45 | 29 | 35 |
| **34 Cr 4** | **1.7033** | 460 | 700 to 850 | 15 | 45 | 34 | 40 |
| **37 Cr 4** | **1.7034** | 510 | 750 to 900 | 14 | 40 | 29 | 35 |
| **41 Cr 4** | **1.7035** | 560 | 800 to 950 | 14 | 40 | 29 | 35 |
| **25 CrMo 4** | **1.7218** | 450 | 700 to 850 | 15 | 60 | 39 | 50 |
| **34 CrMo 4** | **1.7220** | 550 | 800 to 950 | 14 | 55 | 34 | 45 |
| **42 CrMo 4** | **1.7225** | 650 | 900 to 1100 | 12 | 50 | 29 | 35 |
| **34 CrNiMo 6** | **1.6582** | 800 | 1000 to 1200 | 11 | 50 | 34 | 45 |
| **30 CrNiMo 8** | **1.6850** | 900 | 1100 to 1300 | 10 | 45 | 29 | 35 |

[1] $R_e$ = yield strength; $R_{p\,0,2}$ = 0,2 % proof strength; $R_m$ = tensile strength; $A_5$ = elongation after fracture ($L_0 = 5d_0$); $A_v$ = impact value; $Z$ = reduction in area after fracture.

[2] Except for the specifications regarding the impact value determined on ISO U-notch test pieces, the specifications for alloy steels are equivalent to those given in DIN 17 200, March 1987 edition.

[3] Specification of dimensional limits does not imply that full quenching and tempering of the steels is permitted to achieve a largely martensitic structure up to the specified test piece location. The depth of hardening is to be obtained from the end quench curves (see figures 1 a to 1 l).

[4] •• The values specified here do not necessarily apply for wire rod quenched and tempered in coils; they shall be agreed, where required.

[5] Mean from three tests. One individual value may be lower than the minimum value by not more than 30 %.

[6] •• Unless otherwise agreed at the time of ordering, the manufacturer is to decide whether testing is to be performed using an ISO U-notch or V-notch test piece. The revised edition of this standard will only specify values for the ISO V-notch test piece.

[7] •• If checking of impact values has been agreed for test pieces having non-standard sizes (see DIN 1654 Part 1, subclause 8.4.4, last sentence), the values to be complied with shall also be agreed.

Table 6. **Limiting values of Rockwell C hardness determined in the end quench test**[1), 2), 3), 4)]
(Hardness values not given in this table can be obtained from figures 1a to 1l.)

| Steel grade | | Limits of hardenability band | Hardness, in HRC, at a distance from quenched end, in mm | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material designation | Material number | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 13 | 15 | 20 | 25 | 30 |
| Cq 35[5)] | 1.1172[5)] | Maximum | 58 | 57 | 55 | 53 | 49 | 41 | 34 | 31 | 28 | 27 | 26 | 25 | 24 | 23 | 20 | – |
| | | Minimum | 48 | 40 | 33 | 24 | 22 | 20 | – | – | – | – | – | – | – | – | – | – |
| Cq 45[5)] | 1.1192[5)] | Maximum | 62 | 61 | 61 | 60 | 57 | 51 | 44 | 37 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 |
| | | Minimum | 55 | 51 | 37 | 30 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | – | – | – |
| | | | Hardness, in HRC, at a distance from quenched end, in mm | | | | | | | | | | | | | | | |
| | | | 1,5 | 3 | 5 | 7 | 9 | 11 | 13 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | |
| 38 Cr 2[5), 6)] | 1.7003[5), 6)] | Maximum | 59 | 57 | 54 | 49 | 43 | 39 | 37 | 35 | 32 | 30 | 27 | 25 | 24 | 23 | 22 | |
| | | Minimum | 51 | 46 | 37 | 29 | 25 | 22 | 20 | – | – | – | – | – | – | – | – | |
| 46 Cr 2[5), 6)] | 1.7006[5), 6)] | Maximum | 63 | 61 | 59 | 57 | 53 | 47 | 42 | 39 | 36 | 33 | 32 | 31 | 30 | 29 | 29 | |
| | | Minimum | 54 | 49 | 40 | 32 | 28 | 25 | 23 | 22 | 20 | – | – | – | – | – | – | |
| 34 Cr 4[6)] | 1.7033[6)] | Maximum | 57 | 57 | 56 | 54 | 52 | 49 | 46 | 44 | 39 | 37 | 35 | 34 | 33 | 32 | 31 | |
| | | Minimum | 49 | 48 | 45 | 41 | 35 | 32 | 29 | 27 | 23 | 21 | 20 | – | – | – | – | |
| 37 Cr 4[6)] | 1.7034[6)] | Maximum | 59 | 59 | 58 | 57 | 55 | 52 | 50 | 48 | 42 | 39 | 37 | 36 | 35 | 34 | 33 | |
| | | Minimum | 51 | 50 | 48 | 44 | 39 | 36 | 33 | 31 | 26 | 24 | 22 | 20 | – | – | – | |
| 41 Cr 4[6)] | 1.7035[6)] | Maximum | 61 | 61 | 60 | 59 | 58 | 56 | 54 | 52 | 46 | 42 | 40 | 38 | 37 | 36 | 35 | |
| | | Minimum | 53 | 52 | 50 | 47 | 41 | 37 | 34 | 33 | 29 | 26 | 23 | 21 | – | – | – | |
| 25 CrMo 4[6)] | 1.7218[6)] | Maximum | 52 | 52 | 51 | 50 | 48 | 46 | 43 | 41 | 37 | 35 | 33 | 32 | 31 | 31 | 31 | |
| | | Minimum | 44 | 43 | 40 | 37 | 34 | 32 | 29 | 27 | 23 | 21 | 20 | – | – | – | – | |
| 34 CrMo 4[6)] | 1.7220[6)] | Maximum | 57 | 57 | 57 | 56 | 55 | 54 | 53 | 52 | 48 | 45 | 43 | 41 | 40 | 40 | 39 | |
| | | Minimum | 49 | 49 | 48 | 45 | 42 | 39 | 36 | 34 | 30 | 28 | 27 | 26 | 25 | 24 | 24 | |
| 42 CrMo 4[6)] | 1.7225[6)] | Maximum | 61 | 61 | 61 | 60 | 60 | 59 | 59 | 58 | 56 | 53 | 51 | 48 | 47 | 46 | 45 | |
| | | Minimum | 53 | 53 | 52 | 51 | 49 | 43 | 40 | 37 | 34 | 32 | 31 | 30 | 30 | 29 | 29 | |
| 34 CrNiMo 6[6)] | 1.6582[6)] | Maximum | 58 | 58 | 58 | 58 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | |
| | | Minimum | 50 | 50 | 50 | 50 | 49 | 48 | 48 | 48 | 48 | 47 | 47 | 47 | 46 | 45 | 44 | |
| 30 CrNiMo 8[6)] | 1.6580[6)] | Maximum | 56 | 56 | 56 | 56 | 55 | 55 | 55 | 55 | 55 | 54 | 54 | 54 | 54 | 54 | 54 | |
| | | Minimum | 48 | 48 | 48 | 48 | 47 | 47 | 47 | 46 | 46 | 45 | 45 | 44 | 44 | 43 | 43 | |

[1)] •• For unalloyed steel, at a distance of 4 mm from the quenched end, a restriction of the hardenability band to two-thirds, either from the upper or the lower limiting curve (see table 7) may be agreed. Where required, a similar agreement may additionally be made for a distance of 1 mm. If a restriction with respect to the upper limiting curve is required, symbol HH and the associated distance from the end face, $x$ (i.e. HH 4), shall be specified in the order; if a restriction with respect to the lower limiting curve is required, symbol HL and the associated distance from the end face, $x$ (i.e. HL 4), shall be specified in the order. If, at the same time, the restriction is also to apply for a distance of 1 mm from the end face, a 1 shall be placed before the 4 (i.e. HL 14).

[2)] •• For alloy steel, hardenability bands restricted in comparison with the original band determined in the end quench test, i.e. restricted with respect to the upper limiting curve or the lower limiting curve (see figures 1c to 1l, may be agreed at the time of ordering. If a restriction with respect to the upper limiting curve is required, symbol HH shall be specified in the order; if a restriction with respect to the lower limiting curve is required, symbol HL shall be specified in the order.

[3)] •• Within the context of the conditions specified, particular characteristic values for hardenability in the end quench test may be agreed at the time of ordering.

[4)] See Explanatory notes to DIN 17 200.

[5)] The limiting values of Rockwell C hardness are to be regarded as provisional for this steel.

[6)] The limiting values of Rockwell C hardness are identical with those given in DIN 17 200.

Table 7. **Restriction of hardenability bands at one or two distances from the quenched ends in the case of unalloyed steel[1])**

| Steel grade | | Hardness, in HRC, at a distance from quenched end, in mm, of | | Restriction of hardenability band[2]) |
|---|---|---|---|---|
| Material designation | Material number | 1 | 4 | |
| **Cq 35** | **1.1172** | 51 to 58 | 34 to 53 | HH |
| | | 48 to 55 | 24 to 43 | HL |
| **Cq 45** | **1.1192** | 57 to 62 | 41 to 60 | HH |
| | | 55 to 60 | 30 to 50 | HL |

[1]) See also table 6 and figures 1a and 1b.
[2]) See footnote 1 to table 6.

Table 8. **Diameters up to which a minimum core hardness of 40, 45 or 48 HRC shall be present in the steel after quench hardening in a high-duty quenching oil[1])**

| Steel grade | | Core hardness, in HRC | Maximum diameter, in mm |
|---|---|---|---|
| Material designation | Material number | | |
| Steels free of boron | | | |
| **Cq 35** | **1.1172** | 40 | 8 |
| **Cq 45** | **1.1192** | 40 | 12 |
| **38 Cr 2** | **1.7003** | 40 | 16 |
| **46 Cr 2** | **1.7006** | 40 | 20 |
| **34 Cr 4** | **1.7033** | 40 | 22 |
| **37 Cr 4** | **1.7034** | 40 | 24 |
| **41 Cr 4** | **1.7035** | 40 | 26 |
| **25 CrMo 4** | **1.7218** | 40 | 18 |
| **34 CrMo 4** | **1.7220** | 45 | 20 |
| **42 CrMo 4** | **1.7225** | 48 | 28 |
| **34 CrNiMo 6** | **1.6582** | 48 | 35 |
| **30 CrNiMo 8** | **1.6580** | 45 | 60 |
| Boron alloy steels[2]) | | | |
| **22 B 2** | **1.5508** | 40 | 9 |
| **28 B 2** | **1.5510** | 40 | 14 |
| **35 B 2** | **1.5511** | 40 | 18 |
| **19 MnB 4** | **1.5523** | 40 | 15 |

[1]) The values only apply to Cq 35 to 46 Cr 2 steels if the steel ordered is not to be a fine grain steel (see subclause 7.7.1 of DIN 1654 Part 1).
[2]) The values for these steels are provisional and may have to be corrected in the light of new findings.

Table 9. **Temperatures for end quench test and for heat treatment**[1])

| Steel grade | | Hardening temperature in hardenability test[2]), in °C | Quench hardening, in °C | Quenching medium[3]) | Tempering[4]), in °C | Normalizing, in °C |
|---|---|---|---|---|---|---|
| Material designation | Material number | | | | | |
| Steels free of boron[5]) | | | | | | |
| **Cq 22** | **1.1152** | 880 | 860 to 890 | Water | 540 to 680 | 880 to 910 |
| **Cq 35** | **1.1172** | 870 | 840 to 880 | Water, oil | 540 to 680 | 860 to 890 |
| **Cq 45** | **1.1192** | 850 | 820 to 860 | Water, oil | 540 to 680 | 840 to 870 |
| **38 Cr 2** | **1.7003** | 850 | 830 to 870 | Water, oil | 540 to 680 | 850 to 880 |
| **46 Cr 2** | **1.7006** | 850 | 820 to 860 | Water, oil | 540 to 680 | 840 to 870 |
| **34 Cr 4** | **1.7033** | 850 | 830 to 870 | Water, oil | 540 to 680 | 850 to 890 |
| **37 Cr 4** | **1.7034** | 850 | 825 to 865 | Oil, water | 540 to 680 | 845 to 885 |
| **41 Cr 4** | **1.7035** | 850 | 820 to 860 | Oil, water | 540 to 680 | 840 to 880 |
| **25 CrMo 4** | **1.7218** | 860 | 840 to 880 | Water, oil | 540 to 680 | 860 to 900 |
| **34 CrMo 4** | **1.7220** | 850 | 830 to 870 | Oil, water | 540 to 680 | 850 to 890 |
| **42 CrMo 4** | **1.7225** | 850 | 820 to 860 | Oil, water | 540 to 680 | 840 to 880 |
| **34 CrNiMo 6** | **1.6582** | 850 | 830 to 860 | Oil | 540 to 680 | 850 to 880 |
| **30 CrNiMo 8** | **1.6580** | 850 | 830 to 860 | Oil | 540 to 680 | 850 to 880 |
| Boron alloy steels[6]) | | | | | | |
| **22 B 2** | **1.5508** | 880 | 860 to 890 | Water | 550 to 660 | 880 to 910 |
| **28 B 2** | **1.5510** | 850 | 850 to 890 | Water, Oil | 550 to 660 | 870 to 900 |
| **35 B 2** | **1.5511** | 850 | 840 to 880 | Water, Oil | 550 to 660 | 860 to 890 |
| **19 MnB 4** | **1.5523** | 890 | 870 to 910 | Water, Oil | 400 to 600 | 880 to 920 |

[1]) Except for the hardening temperatures in the end quench test, the values are provisional; in practice, the treatment conditions shall be selected as a function of the desired properties.

[2]) End quench test and checking of core hardness.

[3]) Quenching medium is a function of steel grade, workpiece shape and dimensions.

[4]) Cooling in air.

[5]) The specifications for these steels are identical with those given in DIN 17 200.

[6]) The values for these steels are provisional and may have to be corrected in the light of new findings.

## Standards referred to

| | |
|---|---|
| DIN 1654 Part 1 | Cold heading and cold extruding steels; technical delivery conditions, general |
| DIN 17200 | Steels for quenching and tempering; technical delivery conditions |
| EN 10020 | Definitions regarding classification of steel grades |

## Previous editions

DIN 1654: 05.43, 08.54; DIN 1654 Part 4: 03.80.

## Amendments

The following amendments have been made to the March 1980 edition.

a) The specifications regarding chemical composition, hardenability, mechanical properties in the quenched and tempered condition and heat treatment have been brought into line with DIN 17200.

b) 19 MnB 4 steels (1.5523) has been included for the first time. The Si content of boron alloy steels has been limited to a maximum of 0,40 %.

c) The specifications regarding the maximum permitted content of oxidic nonmetallic inclusions have been quantified (see DIN 1654 Part 1).

d) The specifications regarding mechanical properties of steel in the treatment conditions in which it is usually supplied have been revised.

e) The standard has been editorially revised; requirement classes are no longer specified.

## Explanatory notes

See DIN 1654 Part 1.

## International Patent Classification

C 22 C 38/00

G 01 N 33/20