



# 39NiCrMo3

**QUENCHED AND TEMPERED STEELS**

Reference standard: EN 10083-3:2006 (withdrawn)

|        |           |       |           |
|--------|-----------|-------|-----------|
| W.-Nr. | 1.6510    | AFNOR | 40NCD3    |
| AISI   | 9840      | BS    | -         |
| UNI    | 39NiCrMo3 | JIS   | -         |
| DIN    | -         | Other | UNE F1282 |

## CHEMICAL COMPOSITION

| C                  | Si            | Mn                 | P                    | S                    | Cr                 | Mo                 | Ni                 |
|--------------------|---------------|--------------------|----------------------|----------------------|--------------------|--------------------|--------------------|
| 0.35-0.43<br>±0.02 | 0.40<br>±0.03 | 0.50-0.80<br>±0.04 | 0.025 max<br>+ 0.005 | 0.035 max<br>+ 0.005 | 0.60-1.00<br>±0.05 | 0.15-0.25<br>±0.03 | 0.70-1.00<br>±0.05 |

Cast analysis composition, % by mass | Second row: permissible deviations of the product analysis

Can be supplied with a lead (Pb) addition of 0.15 to 0.35% for improved machinability.

## TEMPERATURE IN °C

| Hot working                   | Normalising +N                                                           | Hardening +Q                            | Hardening +Q                   | Tempering +T                                   | Stress relieving +SR                        |
|-------------------------------|--------------------------------------------------------------------------|-----------------------------------------|--------------------------------|------------------------------------------------|---------------------------------------------|
| 1,100-900 °C                  | 860 °C<br>in air                                                         | 850 °C<br>in oil or polymer             | 840 °C<br>in water             | 550-650 °C<br>in air                           | 50 °C below the<br>tempering<br>temperature |
| Machinability<br>annealing +A | Isothermal<br>annealing +I                                               | Critical points                         | Jominy test-piece<br>hardening | Preheating for<br>welding                      | Post-weld stress<br>relieving               |
| 700 °C<br>in air (max 240 HB) | 820 °C, furnace<br>cooling<br>down to 650 °C<br>then air<br>(195-240 HB) | AC1 740 • AC3 790<br>Ms 330 • Mf 110 °C | 850 °C<br>in water             | 300 °C<br>(~ 285 HB in the<br>as-rolled state) | 550 °C, furnace<br>cooling                  |

## MECHANICAL PROPERTIES

| HOT-ROLLED - Longitudinal tensile test at 20 °C                                           |         |                        |                              |           |           |              |         |
|-------------------------------------------------------------------------------------------|---------|------------------------|------------------------------|-----------|-----------|--------------|---------|
| Mechanical properties in the quenched and tempered condition, EN 10083-3:2006 (withdrawn) |         |                        |                              |           |           |              |         |
| Diameter/thick. (in mm)                                                                   |         | R<br>N/mm <sup>2</sup> | ReH<br>N/mm <sup>2</sup> min | A%<br>min | Z%<br>min | KV2<br>J min | HBW     |
| >                                                                                         | ≤       |                        |                              |           |           |              |         |
| -                                                                                         | 16/8    | 980-1,180              | 785                          | 11        | 40        | -            | 295-354 |
| 16/8                                                                                      | 40/20   | 930-1,130              | 735                          | 11        | 40        | 35           | 278-339 |
| 40/20                                                                                     | 100/60  | 880-1,080              | 685                          | 12        | 45        | 40           | 263-327 |
| 100/60                                                                                    | 160/100 | 830-980                | 635                          | 12        | 50        | 40           | 249-295 |
| 160/100                                                                                   | 250/160 | 740-880                | 540                          | 13        | 50        | 40           | 224-263 |

ReH = upper yield strength; where no marked yield occurs, Rp 0.2 applies | KV2 = Charpy V-notch impact energy, 2 mm striker radius, average of 3 test pieces

| TEMPERING TABLE *           |       |       |       |       |       |       |       |       |       |       |       |      |      |
|-----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| R<br>N/mm <sup>2</sup>      | 2,160 | 2,070 | 1,950 | 1,820 | 1,700 | 1,580 | 1,500 | 1,430 | 1,340 | 1,220 | 1,100 | 950  | 800  |
| Rp 0.2<br>N/mm <sup>2</sup> | 1,440 | 1,520 | 1,540 | 1,520 | 1,490 | 1,440 | 1,370 | 1,290 | 1,220 | 1,110 | 980   | 830  | 670  |
| HB                          | 577   | 560   | 525   | 496   | 468   | 442   | 426   | 409   | 390   | 362   | 336   | 286  | 240  |
| HRC                         | 56    | 55    | 53    | 51    | 49    | 47    | 45.5  | 44    | 42    | 39    | 36    | 30   | 22.5 |
| A %                         | 8.0   | 9.8   | 10.4  | 10.6  | 10.7  | 10.8  | 11.0  | 11.5  | 12.5  | 13.8  | 16.0  | 19.0 | 22.0 |
| Z %                         | 30    | 42    | 48    | 52    | 53    | 53    | 54    | 55    | 56    | 57    | 60    | 63   | 68   |
| Kv J                        | 28    | 31    | 32    | 28    | 28    | 27    | 27    | 28    | 36    | 46    | 86    | 114  | 128  |
| °C                          | 100   | 150   | 200   | 250   | 300   | 350   | 400   | 450   | 500   | 550   | 600   | 650  | 700  |

\* Test condition: Ø 10 mm round bar quenched in oil at 850 °C. Reference values at room temperature; the impact row is a product value, test piece not specified

| ANNEALED AND COLD-DRAWN +A+C - Longitudinal tensile test at 20 °C - EN 10277-5:2008 |     |                            |                                 |           |            |
|-------------------------------------------------------------------------------------|-----|----------------------------|---------------------------------|-----------|------------|
| Diameter (in mm)                                                                    |     | R<br>N/mm <sup>2</sup> min | Rp 0.2<br>N/mm <sup>2</sup> min | A%<br>min | HBW<br>max |
| >                                                                                   | ≤   |                            |                                 |           |            |
| 5**                                                                                 | 10  | -                          | -                               | -         | 295        |
| 10                                                                                  | 16  | -                          | -                               | -         | 290        |
| 16                                                                                  | 40  | -                          | -                               | -         | 285        |
| 40                                                                                  | 63  | -                          | -                               | -         | 280        |
| 63                                                                                  | 100 | -                          | -                               | -         | 280        |

| QUENCHED AND TEMPERED, COLD-DRAWN +QT+C - Longitudinal tensile test at 20 °C - EN 10277-5:2008 |     |                        |                                 |           |                  |
|------------------------------------------------------------------------------------------------|-----|------------------------|---------------------------------|-----------|------------------|
| Diameter (in mm)                                                                               |     | R<br>N/mm <sup>2</sup> | Rp 0.2<br>N/mm <sup>2</sup> min | A%<br>min | HBW<br>for info. |
| >                                                                                              | ≤   |                        |                                 |           |                  |
| 5                                                                                              | 10  | 980-1,180              | 735                             | 8         | 295-354          |
| 10                                                                                             | 16  | 930-1,130              | 700                             | 8         | 278-339          |
| 16                                                                                             | 40  | 930-1,130              | 700                             | 9         | 278-339          |
| 40                                                                                             | 63  | 880-1,080              | 625                             | 10        | 263-327          |
| 63                                                                                             | 100 | 880-1,080              | 600                             | 10        | 263-327          |

\* Values also valid for + Cold-drawn and Quenched-tempered (+C+QT)

| HOT-ROLLED, ANNEALED, PEELED AND ROLLER-BURNISHED<br>EN 10277-5:2008 - Longitudinal tensile test at 20 °C |     |            |
|-----------------------------------------------------------------------------------------------------------|-----|------------|
| Diameter (in mm)                                                                                          |     | HBW<br>max |
| >                                                                                                         | ≤   |            |
| 16                                                                                                        | 40  | 240        |
| 40                                                                                                        | 63  | 240        |
| 63                                                                                                        | 100 | 240        |

| QUENCHED AND TEMPERED, COLD-DRAWN +C +QT<br>EN 10277-5:2008 - Longitudinal tensile test at 20 °C |     |                        |                                 |           |                  |
|--------------------------------------------------------------------------------------------------|-----|------------------------|---------------------------------|-----------|------------------|
| Diameter (in mm)                                                                                 |     | R<br>N/mm <sup>2</sup> | Rp 0.2<br>N/mm <sup>2</sup> min | A%<br>min | HBW<br>for info. |
| >                                                                                                | ≤   |                        |                                 |           |                  |
| 16                                                                                               | 40  | 930-1,130              | 735                             | 11        | 278-339          |
| 40                                                                                               | 63  | 880-1,080              | 735                             | 12        | 263-327          |
| 63                                                                                               | 100 | 880-1,080              | 735                             | 12        | 263-327          |

| FORGED QUENCHED AND TEMPERED - Tensile and impact test at 20 °C<br>UNI 7874:1979 for reference |       |                        |                                 |             |             |               |               |         |
|------------------------------------------------------------------------------------------------|-------|------------------------|---------------------------------|-------------|-------------|---------------|---------------|---------|
| Diameter (in mm)                                                                               |       | R<br>N/mm <sup>2</sup> | Rp 0.2<br>N/mm <sup>2</sup> min | A% L<br>min | A% T<br>min | Kv L<br>J min | Kv T<br>J min | HB      |
| >                                                                                              | ≤     |                        |                                 |             |             |               |               |         |
| -                                                                                              | 100   | 880-1,080              | 685                             | 12          | -           | 40            | -             | 263-327 |
| 100                                                                                            | 250   | 685-835                | 540                             | 13          | 12          | 30            | 25            | 209-250 |
| 250                                                                                            | 500   | 655-805                | 490                             | 15          | 14          | 30            | 25            | 201-241 |
| 500                                                                                            | 1,000 | 635-785                | 440                             | 16          | 15          | 25            | -             | 195-234 |
| 1,000                                                                                          | -     | 590-740                | 390                             | 15          | 14          | 25            | -             | 176-224 |

L = longitudinal | T = tangential

| HARDENABILITY VALUES * |     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|------------------------|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                        | 1.5 | 3  | 5  | 7  | 9  | 11 | 13 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| Min                    | 52  | 51 | 50 | 49 | 48 | 46 | 44 | 43 | 39 | 36 | 34 | 33 | 32 | 31 | 30 |
| Max                    | 60  | 60 | 59 | 58 | 58 | 57 | 57 | 56 | 55 | 52 | 51 | 49 | 48 | 46 | 45 |

\* Jominy in HRC EN 10083-3:2006 (withdrawn) - minimum grain size G5 per UNI 3245 - distance from the quenched end in mm

| Temperature | Elastic modulus<br>GPa |        | Mean expansion                                  |
|-------------|------------------------|--------|-------------------------------------------------|
| ° C         | E long                 | G tang | 10 <sup>-6</sup> K <sup>-1</sup><br>(20 °C → T) |
| 20          | 210                    | 81     |                                                 |
| 100         | -                      | -      | 11.2                                            |