ENGINEERING STEELS + ALLOYS

# 4140 HIGH TENSILE STEEL

4140 is a 1% chromium - molybdenum medium hardenability general purpose high tensile steel - generally supplied hardened and tempered in the tensile range of 850 - 1000 Mpa (condition T).4140 is now available with improved machinability, which greatly increases feeds and/or speeds, while also extending tool life without adversley affecting mechanical properties.
Pre hardened and tempered 4140 can be further surface hardened by flame or induction hardening and by nitriding.
4140 is used extensively in most industry sectors for a wide range of applications such as:
Adapters, Arbors, Axle Shafts, Bolts, Crankshafts, Connection Rods, Chuck Bodies, Collets, Conveyor Pins & Rolls, Ejector Pins, Forks, Gears, Guide Rods, Hydraulic Shafts & Parts,Lathe Spindles, Logging Parts, Milling Spindles, Motor Shafts, Nuts, Pinch Bars, Pins Various, Pinions, Pump Shafts, Rams, Sockets, Spindles, Sprockets, Studs, Tool Holders, Torsion Bars, Worms etc..

| Colour Code | Stocked Sizes | |
|---|---|---|
| Dark Blue (Bar End)  | Rounds | 8 mm to 690 mm Diameter |
| | Hexagons | 19.05 mm to 65 mm A/F |
| | Hollow Bar | 63 mm to 250 mm OD |
| | Square | 32 mm to 130 mm |
| | **Bar Finish** | |
| | Peeled, Cold Drawn, Turned and Polished, Centreless Ground. or Hot Rolled. | |

| **Related Specifications** | |
|---|---|
| Australia | AS 1444-1996-4140 |
| Germany | DIN 17212 W.Nr 1.7223 Type 41CrMo4<br>DIN 17200-1654 W.Nr 1.7225 Type 42CrMo4<br>DIN 17200 W.Nr 1.7227 Type 42CrMoS4 |
| Great Britain | BS970-1955 EN19A<br>BS970 Part 3:1991 709M40 |
| International | ISO 683/II Type 3<br>ISO 683/IV Type 3a<br>ISO 683/IV Type 3b |
| Japan | JIS G 4103 SNCM4<br>JIS G 4105 SCM4<br>JIS G 4105 SCM440 |
| USA | AISI 4140<br>ASTM A29/A29M-91 4140<br>ASTM A322 4140<br>ASTM A331 4140 (Cold Finish)<br>SAE 4140 |

| **Chemical Composition (Base Material)** | | |
|---|---|---|
| | **Min. %** | **Max %** |
| Carbon | 0.36 | 0.44 |
| Silicon | 0.10 | 0.40 |
| Manganese | 0.65 | 1.10 |
| Chromium | 0.75 | 1.20 |
| Molybdenum | 0.15 | 0.35 |

| | | |
|---|---|---|
| Phosphorous | 0 | 0.04 |
| Sulphur | 0 | 0.04 |

**Mechanical Property Requirements for Steels in the Heat-Treated Condition for Turned, Peeled or Ground Finish to AS1444-1996 4140 and BS970 Part 3-1991 709M40**

| Mechanical Property Designation | | R | S | S | *T | U | V | W |
|---|---|---|---|---|---|---|---|---|
| Limited Ruling Section mm | | 250 | 250 | 150 | 100 | 63 | 30 | 20 |
| Tensile Strength Mpa | Min | 700 | 770 | 770 | 850 | 930 | 1000 | 1080 |
| | Max | 850 | 930 | 930 | 1000 | 1080 | 1150 | 1230 |
| 0.2% Proof Stress Mpa | Min | 480 | 540 | 570 | 655 | 740 | 835 | 925 |
| Elongation on $5.65\sqrt{S_0}$ % | Min | 15 | 13 | 15 | 13 | 12 | 12 | 12 |
| Izod Impact J | Min | 34 | 27 | 54 | 54 | 47 | 47 | 40 |
| Charpy Impact J | Min | 28 | 22 | 50 | 50 | 42 | 42 | 35 |
| Hardness Brinell HB | Min | 201 | 233 | 233 | 248 | 269 | 293 | 311 |
| | Max | 255 | 277 | 277 | 302 | 331 | 352 | 375 |

*Material stocked generally in condition T
Check test certificate if critical for end use.

**Mechanical Property Requirements for Steels Heat-Treated, and then Cold Finished to AS 1444 - 1996, and BS 970 Part 3 - 1991 709 M40**

| Mechanical Property Designation | | R | S | T | U | V |
|---|---|---|---|---|---|---|
| Limited Ruling Section | | 63 | 63 | 63 | 63 | 63 |
| Tensile Strength Mpa | Min | 700 | 770 | 850 | 930 | 1000 |
| | Max | 850 | 930 | 1000 | 1080 | 1150 |
| 0.20% Proof Stress Mpa | Min | 525 | 585 | 680 | 755 | 850 |
| Elongation on $5.65\sqrt{S_0}$ % | Min | 12 | 11 | 9 | 9 | 9 |
| Hardness Brinell HB | Min | 201 | 223 | 248 | 269 | 293 |
| | Max | 255 | 277 | 302 | 331 | 352 |

*Material stocked generally in condition T
Check test certificate if critical for end use.

**Forging**

Heat to 1150 °C - 1200 °C maximum, hold until temperature is uniform throughout the section.
Do not forge below 850 °C.Following forging operation the work piece should be cooled as slowly as possible.

**Heat Treatment**

**Annealing**

Heat to 800 °C - 850 °C, hold until temperature is uniform throughout the section and cool in furnace.

**Flame or Induction Hardening**

4140 hardened and tempered bar can be further surface hardened by either the flame or induction hardening methods resulting in a case hardness in excess of Rc 50.Parts should be heated as quickly as possible to the austenitic temperature range (840 C - 870 C) and "required case depth followed by an immediate oil or water quench, depending upon hardness required, workpiece" size/shape and quenching arrangements.
Following quenching to hand warm, most components should be tempered between 150 C - 200 C to remove quenching stresses in the case. This will have little effect on case hardness and will reduce the risk of grinding cracks.

**Hardening**

Heat to 840 °C - 875 °C, hold until temperature is uniform throughout the section, soak for 10 - 15 minutes per 25 mm section, and quench in oil, water, or polymer as required.*Temper immediately while still hand warm.

**Nitriding**

4140 hardened and tempered bar can also be successfully nitrided, giving a surface hardness of up to Rc 60. Nitriding is carried out at 490 ºC - 530 ºC, followed by slow cooling (no quench) reducing the problem of distortion. Parts can therefore be machined to near final size, leaving a grinding allowance only. The tensile strength of the core is usually not affected since the nitriding temperature range is generally below the original tempering temperature employed.

**Normalizing**

Heat to 870 ºC - 900 ºC, hold until temperature is uniform throughout the section, soak for 10 - 15 minutes and cool in still air.

**Stress Relieving**

Heat to 680 ºC - 700 ºC, hold until temperature is uniform throughout the section, soak for 1 hour per 25 mm section, and cool in still air.

**Tempering**

Re-heat to 550 ºC - 700 ºC as required, hold until temperature is uniform throughout the section, soak for 1 hour per 25 mm of section, and cool in still air.

**Notes on Heat Treatment**

Heating temperatures, rate of heating and soaking times will vary due to factors such as work piece size/shape also furnace type employed, quenching medium and work piece transfer facilities etc..Please consult your heat treater for best results.

**Machining**

4140 in the hardened and tempered as supplied condition has good to very good machinability and operations such as sawing, turning, drilling, broaching, hobbing, milling and tapping can be carried out satisfactoraly using machine manufacturers recommendations for suitable tool type - feeds and speeds.

**Welding**

Welding of 4140 in the hardened and tempered condition (as normally supplied), is not recommended and should be avoided if at all possible, as the mechanical properties will be altered within the weld heat affected zone. It is preferred that welding be carried out on 4140 while in the annealed condition, and that the work piece, immediately on cooling to hand warm, is then stress relieved at 595 ºC - 620 ºC prior to hardening and tempering.If welding in the hardened and tempered condition is really necessary, then the work piece, immediately on cooling to hand warm, should be stress relieved at 15 ºC below the original tempering temperature.

**Welding Procedure**

Welding of 4140 in whatever condition should always be carried out using low hydrogen electrodes - please consult your welding consumables supplier.

**Suggested pre-heat temperature**

| **Section** | 25mm | 40mm | 50mm | 75mm | 150mm + |
|---|---|---|---|---|---|
| **ºC** | 370 | 400 | 425 | 455 | 510 |

**Post Welding**

Maximum cooling rate 95 ºC per hour down to 95 ºC, follow by cooling in still air. N.B. No draught.It is recommended that the work piece if possible is wrapped in an heat resistant blanket or buried in sand etc..