CHRONIFER® M-17A

AISI 440A - Martensitic stainless steel

Attributes and particularities

This steel exhibits a remarkable wear resistance in the hardened condition. The Mo addition and high C content of the CHRONIFER® M-17A steel favor its good hardening capacity up to 56 HRc. However, its corrosion resistance in water and steam can only be assured in the hardened, polished, and passivized condition. Its machinability is, as for all martensitic stainless steels with the exception of the free machining grades, modest.

Uses

Thanks to its good wear resistance allied to a fair corrosion resistance, this steel is widely used to make bearings, nozzles, valve components, and the production of cutlery items and cutting components as well as medical, surgical and dental instruments.

Standards

Material Number	~1.4109
ISO	7153-1 (S)
EN	~X70CrMo15
DIN	~X70CrMo15
AISI/SAE	AISI 440A
ASTM	F899
UNS	S44002

Chemical composition (%wt)

C	Si	Mn	P	S	Cr	Mo	Cu	Fe
0.60 0.75	max. 1.00	max. 1.00	max. 0.04	max. 0.03	16.0 18.0	max. 0.75	max. 0.50	balance

Dimensions and tolerances

- Bars Ø < 2.00 mm: ISO h8
- Bars Ø ≥ 2.00 mm: ISO h6 (h7, h8)
- Wires Ø ≥ 0.80 mm: ISO fg7, for coils for Escomatic
- Out of roundness: max ½ of tolerance

Other tolerances on request

Executions and Delivery conditions

Standard: in bars 3 m (+50/0 mm) and in coils for Escomatic

- Bars Ø ≥ 2.00 mm: cold drawn, ground polished, Ra max. 0.4 µm (N5)
  pointed 60°, chamfered 45°
  eddy-current check according to EN10277-1, Table 1
- Bars Ø < 2.00 mm: surface condition: cold drawn
- Wires Ø < 6.00 mm: surface condition: cold drawn, coils for Escomatic
- Bars Ø ≥ 6.00 mm: SWISSLINE

Other executions on request

Availability

Standard dimensions on stock, see: Sale program

Mechanical properties

Standard delivery condition: Strength, Rm/UTS: 700 - 950 MPa
UTS function of the diameter
Hardening capability: up to 56 HRc

Cutting condition

Machinability: fair
longs chips
Cutting speed: $V_c \approx 20$ - 30 m/min.
Lubricant-coolant: individual choice

- The optimal cutting conditions depend on the machine tool, cutting tools, chip dimensions, lubricant-cooling fluid, as well as the tolerances and surface the roughness to be achieved.

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Forming

Warm: forging: 950 – 1200°C, preferably > 1020°C, slow cooling
Normal heating up to 760°C, then slow heating up to the preferred forming temperature of 1040-1200°C. Slow cooling
- Not recommended below 925°C.

Cold: Feasible but difficult
Intermediary annealing during cold working: 600 – 680°C, air cooling
UTS after annealing: ≈ 750 MPa

Welding

Difficult. Not advisable.

Annealing

Soft anneal:
- 845 – 870°C / 2 - 4h / very slow furnace cooling down to 600°C

Intermediary anneals: 750 – 825 °C, slow cooling
- Recommended minimum cold reduction before annealing ≥ 10 – 15%, this to prevent a possible too strong grain growth.

Quenching

Primary quenching: 1000 – 1030°C, oil, air, or gas
Optional: Secondary quench by sub-zero cooling
Recommendation: To obtain the best efficiency, this secondary quenching must be made without delay after the primary one.
- -20 down to -80°C/12 – 48h, preferably -80°C/12 – 24h

Or cryo-treatment (deep cryo-cooling):
- -196°C/6 – 12h, progressive or step by step cooling, to avoid cracking.

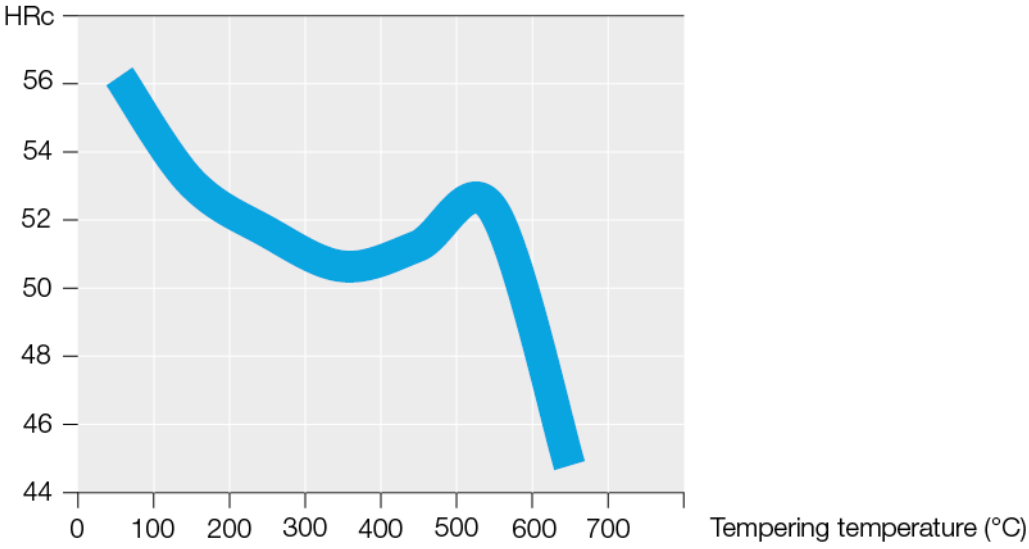
More info.

Tempering

According to needs, see Tempering diagram
- Not recommended temperature range: 400 – 580°C (brittleness range)

Not advisable because of the increased risk of inter-granular corrosion.

Tempering diagram



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Microstructures

Delivery conditions: “annealed“ and “annealed + cold formed“ : Ferrite + carbides
Machining microstructure: Ferrite + carbides
Quench and tempered condition: Martensite + carbides
Hard machining microstructure: Plain martensite or Martensite + carbides
Microstructure for an optimal polishing: Stress relieved martensite
Polishing microstructure: Stress relieved martensite or Martensite + carbides

Polishing

- Optimal in the quenched and tempered < 150°C.

Laser marking

- The laser marking heat in the Heat Affected Zone (HAZ) may modify the local microstructure and affect negatively its corrosion resistance. More info.

Pickling and passivation

It is strongly recommended to use passivation procedures and products effectively adapted to the treatment of martensitic stainless steels.

- To avoid a possible staining by a “flash back“ reaction, it is also strongly recommended to always pickle the surfaces before the passivation procedure. More info.

Corrosion resistance

Optimum: Clean, quenched, tempered, fine polished, and passivized surfaces.

- Conditions to avoid: “annealed“ and “annealed + cold deformed“. These conditions should be avoided because of the increased risk of inter-granular corrosion. These two conditions are definitively not recommended for the permanent use of parts.
- The possible formation of oxides and scaling can strongly decrease the corrosion resistance. These oxides should always be eliminated either mechanically, or chemically by pickling.

Elementary precautions

- The simplest and easiest precautions are always to keep the parts clean, free of working residues, polished, and correctly dried.
- Use only chloride free disinfection solutions, cleaning and washing solutions and products. More info.

Physical properties

Properties	Units	Temperature (°C)				
		20	200	300	400	500
Density	g cm^{-3}	7.75				
Young modulus E	GPa	215			190	
Electrical resistance	Ω mm^2 m^{-1}	0.70				
Thermal expansion	m m^{-1} K^{-1}	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C
	10^{-6}	10.4	10.8	11.2	11.6	
Thermal conductivity	W m^{-1} K^{-1}	15.5				
Specific heat	J kg^{-1} K^{-1}	460				
Melting range	1485 – 1420 °C					
Magnetism	Ferromagnetic, can be magnetized More info.					