



# CHRONIFER® M-13

1.4034/AISI 420 - Martensitic stainless steel

## Attributes and Particularities

The CHRONIFER® M-13 steel has a low S content. In order to obtain a satisfactory corrosion resistance in water and water steam, the machined parts must previously be heat treated, fine polished and passivized. In this condition, this grade has a similar wear resistance as its equivalent free machining grade CHRONIFER® Labor M-13 (1.4035 alias 1.4034+S) with a higher S content.

## Uses and Applications

This steel grade is well adapted for the production of turned part such as bolts and nuts, screws, valves, nozzles, faucet and pump parts. It is also used for the manufacture of wear resistant parts such as bearings, medical, surgical and dental instruments as well as in the agro and food industries.

## Applicable standards

Material number	1.4034
ISO	7153-1 (D)
EN 10088-3 / DIN	X46Cr13,
AISI/SAE/ASTM	AISI 420, AISI 420C, ASTM F899, A276, A959
NF	S 94-090
AFNOR	X46Cr13 (former Z44C14)
JIS	SUS420
UNS	S 42000

## Chemical composition (%wt)

C	Si	Mn	P	S	Cr	Ni	Fe
0.43	max.	max.	max.	max.	12.5	max.	balance
0.50	1.00	1.00	0.04	0.03	14.5	1.00	

## Dimensions and tolerances

- Bars  $\varnothing < 2.00$  mm: ISO h8
  - Bars  $\varnothing \geq 2.00$  mm: ISO h6 (h7)
  - Wires  $\varnothing \geq 0.80$  mm: ISO fg7, coils for Escomatic
  - Out of roundness: max 1/2 of tolerance
- Other executions on request

## Executions and Delivery conditions

- Standard: in bars 3 m (+50/0 mm), coils for Escomatic
- Bars  $\varnothing \geq 2.00$  mm: cold drawn, ground polished, rugosity  $R_a < 0.4 \mu\text{m}$  (N5) eddy-current check according to EN10277-1, Table 1 pointed and chamfered
  - Bars  $\varnothing < 2.00$  mm: surface condition: cold drawn
  - Wires  $\varnothing \leq 6.00$  mm: surface condition: cold drawn, coils for Escomatic
- Other executions on request

## Availability

Standard dimensions on stock, see: [Sale program](#)

## Mechanical properties

- Standard delivery condition:
- UTS Strength: depends on diameter
- $\varnothing 1.00$  up to  $< 4.50$  mm: 775 – 925 MPa
- $\varnothing > 4.50$  mm: 725 – 925 MPa
- Hardening capability: up to 55 HRC

## Cutting conditions

- Machinability: good; build long chips
- Cutting speed:  $V_c \approx 25 - 40$  m/min.
- Lubricant-coolant: individual choice
- The optimal cutting conditions depend on the machine tool, the cutting tools, the chip dimensions, the lubricant-cooling fluid, as well as the tolerances and surface the roughness to be achieved.



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- Forming** Warm: forging: 950 – 1100°C, slow furnace cooling
  - Above 1050°C: danger of rapid grain growth
 Cold: relatively difficult, not recommended

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- Welding** Difficult, not recommended

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- Annealing** Soft anneal: 750 – 830°C / 2-4h, slow furnace cooling 30°C/h down to 600°C

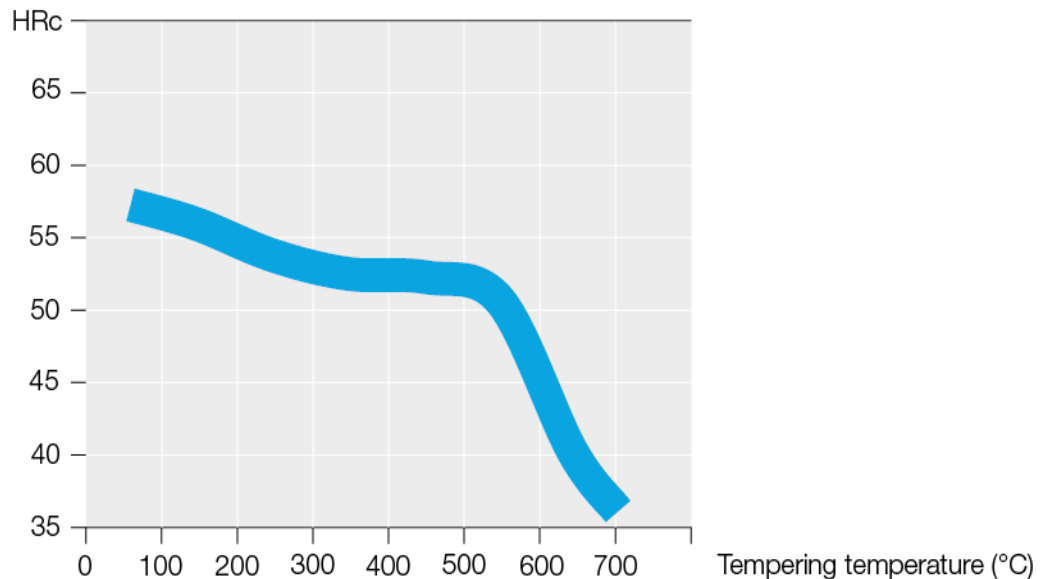
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- Quenching** Primary quenching: 1000-1050°C / oil, or fast air or gas cooling  
 Optional: secondary quenching by sub-zero cooling  
 -20 down to -80°C/12 – 48h, preferably -80°C/12 – 24  
 or cryo-treatment (deep cryo-cooling):  
 -196°C/6 – 12h, progressive cooling or step by step cooling, to avoid cracking.
  - To obtain the best efficiency, this secondary quench must be made without delay after the primary one. [More info.](#)

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- Tempering** Tempering according to needs, see Tempering diagram
  - Not recommended temperature range: 400 – 580°C (brittleness range) and increased risk of inter-granular corrosion.

**Figure 1**  
Tempering diagram





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## Microstructures

Delivery conditions: “annealed“ and “annealed + cold drawn“: Ferrite + carbides

- Machining microstructure: Ferrite + carbides
- Conditions after heat treatment: Martensite + carbides
- Microstructure for hard machining: Martensite or Martensite + carbides
- Microstructure for optimal polishing: Stress relieved martensite
- Microstructure for polishing: Martensite or Martensite + carbides

## Polishing

Well indicated for polishing

- Optimal condition: quenched and tempered < 200°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 adapted to the treatment of martensitic stainless steels.

- To avoid a possible staining by a “flash back“ reaction, it is strongly recommended to 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 due to the increased inter-granular corrosion risk. These two conditions must be avoided for any permanent uses.
- The possible formation of oxides and scaling can strongly decrease the corrosion resistance. These oxides must 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 <sup>-3</sup>	7.70				
Young Modulus E	GPa	215			190	
Electrical resistance	Ω mm <sup>2</sup> m <sup>-1</sup>	0.70				
Thermal expansion	m m <sup>-1</sup> K <sup>-1</sup> 10 <sup>-6</sup>	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C
		10.5	11.0	11.5	12.0	12.0
Thermal conductivity	W m <sup>-1</sup> K <sup>-1</sup>	30				28.7
Specific heat	J kg <sup>-1</sup> K <sup>-1</sup>	460				
Melting range	1500 – 1430 °C					
Magnetism	Ferromagnetic, can be magnetized. See Figure 2 Magnetism					



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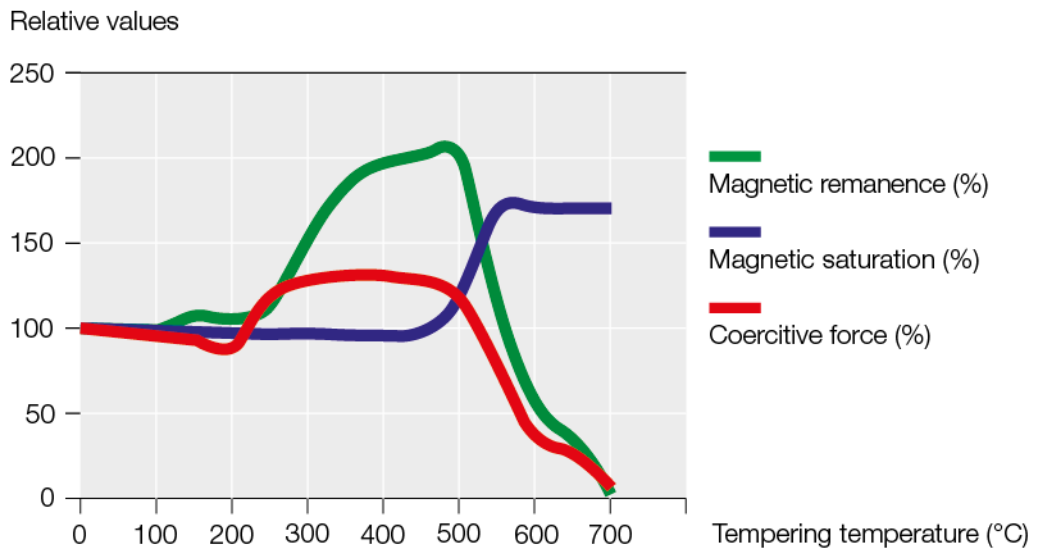
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**Magnetism**

Figure 2 shows the dependence of the magnetic properties of martensitic stainless steels in function of the tempering and annealing temperatures. The values in the hardened quenched condition have been taken as 100, as normal reference. Between approximately 200°C and 500°C the magnetic properties become progressively hard. From 500°C and above they drops continuously to reach their minimum in the annealed condition at approximately > ca. 750°C.

**Figure 2**  
Relative magnetic properties

Typical diagram



Selon S. S. M. Tavares and al: Magnetic properties of an AISI 320 martensitic steel  
Journal of Alloys and Components 312 (2000) 307-314

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