L.KLEIN SA
PREMIUM STEEL & METALS
SINCE 1946

CHRONIFER® M-15

1.4057 / AISI – Martensitic stainless steel

Distinctive feature and main attributes

The CHRONIFER® M-15 steel has a high Cr and low S contents. It is ESR remelted. The low C and S contents, as well as the Ni addition enhance its good corrosion resistance. It has the second best corrosion resistance of all martensitic stainless steels after the powder metallurgy made CHRONIFER® M-15X steel. However, as for all martensitic stainless steels, it exhibits its best values in the quenched, tempered, polished and passivized condition. In this condition, it exhibits a good resistance to water and water steam (autoclave sterilization). Its high mechanical properties indicate it for numerous applications in various industries.

Use and application range

This steel is well adapted for medical, surgical and dental instruments. It is well indicated for the production of parts for many industries, such as i.e. automotive, chemical, oil and petrochemical, paper, agricultural, food, aerospace, instrumentation and precision mechanical engineering, natural energy extractions and conversions.

Norms

Material No.	1.4057
DIN	X17CrNi16-2 (formerly X20CrNi17-2)
ISO	X17CrNi16-2
AISI / SAE / ASTM	ASTM F899, AISI 431
AFNOR	X17CrNi16-2 (formerly Z15 CNi 16.02)
EN 10088-3	X17CrNi16-2 (formerly X21CrNi17)
UNS	S43100
JIS	SUS 431

Chemical composition (% wt)

C	Si	Mn	P	S	Cr	Ni	Fe
0.12 – 0.20	max. 1.00	max. 1.00	max. 0.04	max. 0.03	15.00 – 17.00	1.50 – 2.50	balance

Dimensions and tolerances

- **Bars Ø < 2.00 mm:** ISO h8
- **Bars Ø ≥ 2.00 mm:** ISO h6 (h7)
- **Wires Ø ≥ 0.80 mm:** ISO fg7, 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), coils for Escomatic

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

Other executions on request

Availability

Current dimensions on stock: see product range

Mechanical properties

Standard delivery condition: UTS / Rm strength: ≈ 850 MPa, according to diameter
Hardening capability: up to 47 HRc

Modifications will not be adjusted automatically. Last update 08 / 2024

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Cutting conditions

Machinability: fair to good, build long chips
Cutting speed: $V_c \approx 30 – 40$ 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.

Forming

Warm: forging: 950 – 1'180°C, slow heating up to 850°C, then faster, slow furnace cooling after forging.
This steel tends to inter-granular precipitation of carbides leading to inter-crystalline corrosion. Therefore, a solution anneal after warm forming is recommended.

Cold: Feasible after anneal at 750 – 825°C, slow cooling, Rm ≤ 760 MPa

Welding

Difficult. Not recommended.
The HAZ (Heat Affected Zone) of the welding may locally sensibilize the microstructure, and lower its corrosion resistance. A new solution anneal after welding may be necessary.

Annealing

Soft anneal: 650 – 800°C / 1 – 2 h, slow furnace cooling.
A minimum amount of cold reduction of ≥ 10 – 15% is recommended before annealing to prevent a potentially too strong grain growth.

Quenching

Primary quenching: 950 – 1'060°C, water, air or gas quenching
- Above 1'050°C there is a potential danger of too strong grain growth.

Option: Secondary sub-zero quenching:
- - 20°C / 12 – 48 h, preferably - 80°C / 12 – 24 h
- - 196°C / 6 – 12 h, a stepped cooling is recommended to prevent any potential cracking.

The secondary quench must be made without delay after the primary one. more info

Tempering

Tempering: according to requirements, see tempering diagram
- The temperature range 420 – 520°C should be avoided (potential brittleness).
- The tempering conditions depend of the required UTS / Rm strength. < 200°C to obtain the maximum hardness.

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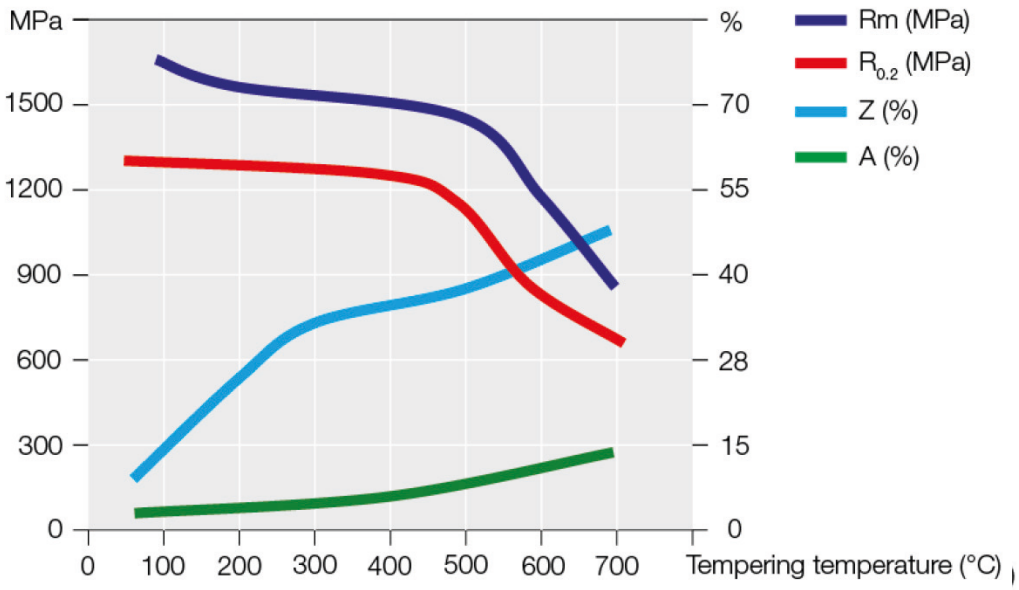
Tempering diagram



IMPORTANT REMARK: The curves of the Tempering diagram above have been measured on probes of 5 mm diameter. They are indicative and shown as references only. The values actually measured on parts may vary as per the part forms, dimensions, and the effective heat treatment carried out.

Microstructures

Delivery condition, "annealed" and "annealed and cold work": Ferrite + carbides

- **Microstructure of the classical machining:** Ferrite + carbides
- **Microstructure of hard machining:** Martensite + carbides
- **Quenched-tempered condition:** Martensite, or Martensite + residual primary carbides
- **Microstructure for polishing at optimal hardness:** Stress relieved martensite
- **Microstructure for polishing: Quenched and tempered < 200°C:** from stress relieved martensite to Martensite + carbides

Polishing

Well adapted to mirror polish, optimal tempered < 200°C

Laser marking

The heating of the laser marking in the HAZ (Heat Affected Zone) can locally sensitize the microstructure and lower its corrosion resistance and mechanical properties. more info

Pickling and passivation

It is always recommended to select pickling and passivation procedures and products correctly adapted to the treatment of martensitic stainless steels.
In order to avoid any potential "flash back" reactions it is recommended to pickle the surface before passivation. more info

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Corrosion resistance

Optimal: Clean, polished, passivized surface in the quenched-tempered condition.
Conditions to avoid: annealed and "annealed + cold deformed". These conditions should be avoided due to the increased inter-granular corrosion risk. They must be avoided for any permanent uses.

Superficial oxidations

The formation of colored oxidations or scales during the heat treatment may strongly lower the corrosion resistance. These oxidations should always be eliminated either mechanically or chemically.

Elementary precautions

The simplest elementary protection precautions against corrosion are:

- To always keep the surfaces clean and polished.
- Avoid the drying of working / use residues on the surface of the parts or instruments before due washing and cleaning.
- Use only chloride free solutions to wash, clean and disinfect the parts or instruments. more info

Physical properties

Properties	*Unit*	*Temperature (°C)*				
		20	200	300	400	500
Density	g cm^{-3}	7.70				
Young modulus E	GPa	205			190	
Electrical resistance	Ω mm^2 m^{-1}	0.70				
Thermal expansion	m m^{-1} K^{-1} 10^{-6}	20 – 100°C 10	20 – 200°C 10.5	20 – 300°C 10.5	20 – 400°C 10.5	20 – 500°C 11.5
Thermal conductivity	W m^{-1} K^{-1}	25				28.7
Specific heat	J kg^{-1} K^{-1}	460				
Melting interval	1'505 – 1'425°C					
Magnetism	Ferromagnetic,can be magnetized. more info					

Disclaimer: The information and data of this informative "Data sheet" are indicative only. They are not use instructions. The users must define and endorse them in each case.

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