CHRONIFER® M-15

1.4057/AISI 431 - Martensitic stainless steel

Features

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.

Uses

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.

Standards

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

Chemical composition (%wt)

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

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: Delivery program

Mechanical properties

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

Cutting conditions

Machinability:	fair to good; build long chips
Cutting speed:	V_c ≈ 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.

Modifications will not be adjusted automatically.
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Forming

Warm: forging: 950 – 1180°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/1-2h, slow furnace cooling.

- A minimum amount of cold reduction of ≥ 10 – 15% is recommended before annealing to prevent a potentially too strong grain growth.

Primary quenching

Primary quenching: 950 – 1060°C, water, air or gas quenching

- Above 1050°C there is a potential danger of too strong grain growth.

Option: Secondary sub-zero quenching

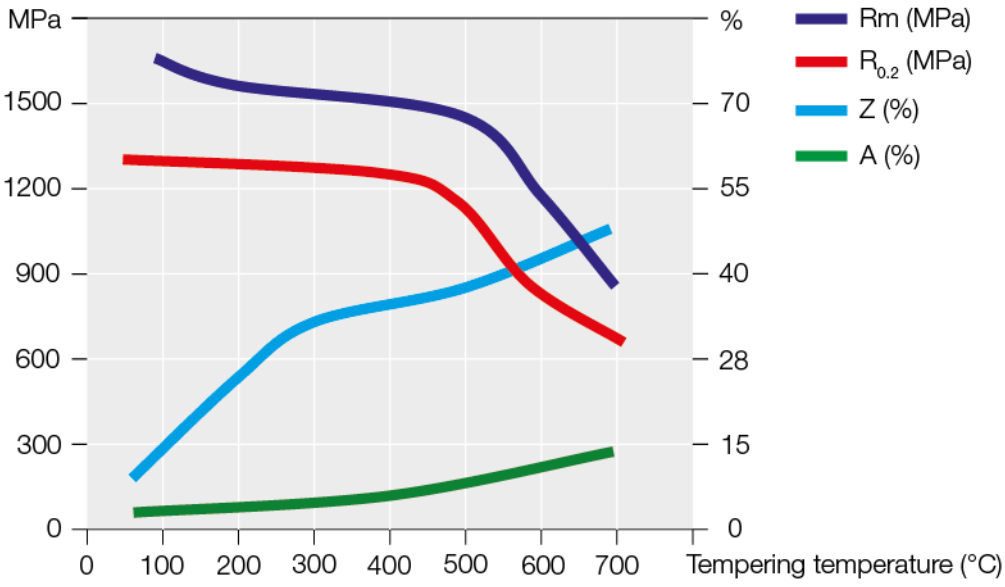
- -20°C/12-48h, preferably -80°C/12-24h
- -196°C/6-12h, a stepped cooling is recommended to prevent any potential cracking.
- The secondary quench must be made without delay after the primary one.
  More info.

Tempering

Tempering: according to requirements, see Tempering diagram

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

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.

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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.

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}	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C
	10^{-6}	10	10.5	10.5	10.5	11.5
Thermal conductivity	W m^{-1} K^{-1}	25				28.7
Specific heat	J kg^{-1} K^{-1}	460				
Melting interval	1505 – 1425 °C					
Magnetism	Ferromagnetic, More info.					

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