CHRONIFER® Labor M-13

1.4034+S/AISI 420F - Martensitic free machining stainless steel

Attributes and Particularities

The free machining CHRONIFER® Labor M-13 steel has a high S content to enhance its machinability. However, it exhibits only a satisfactory corrosion resistance in water and water steam in the hardened, fine polished and passivized condition. In this condition its wear resistance is comparable to this of the CHRONIFER® M-13, 1.4034 grade.

Uses and applications

This steel fulfills the basic elementary requirements for the production of medical, surgical and dental instruments as well as those for table cutlery.

Applicable standards

Material Number	1.4035 (1.4034+S)
EN 10088-3	X46CrS13
DIN	X46CrS13 (formerly X45CrS13)
AFNOR	X45CrS13 (formerly Z44 CF14)
AISI/SAE/ASTM	≈ AISI 420 F
JIS	SUS 420F
UNS	≈ S 42020

Chemical composition (%wt)

C	Si	Mn	P	S	Cr	Mo	Fe
0.43	max.	max.	max.	0.15	12.50	max.	balance
0.50	1.00	1.25	0.04	0.35	14.00	0.60	

Dimensions and tolerances

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

Other tolerances on request

Executions and Delivery conditions

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

- Bars Ø ≥ 2.00 mm: cold drawn, ground polished, Ra 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 execution
- Wires Ø < 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: Strength UTS, function of the diameter

- Bars Ø < 4.50 mm: 775 – 925 MPa
- Bars Ø 4.50 – 16.00 mm: 725 – 905 MPa
- Bars Ø > 16.00 mm: max. 800 MPa

Hardening capacity: up to 55 HRc

Cutting conditions

Machinability: good to very good
build short chips

Cutting speed: V_c ≈ 40 - 55 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.

L. Klein AG • Längfeldweg 110 • CH-2504 Biel/Bienne
Telefon 0041 (0)32 341 73 73 • Telefax 0041 (0)32 341 97 20 • www.kleinmetals.swiss • info@kleinmetals.swiss

CHRONIFER® Labor M-13

1.4034+S/AISI 420F - Martensitic free machining stainless steel

Forming

Warm: forging: 950 – 1100°C, slow furnace cooling
Not recommended below 950°C.

- Above 1050°C there is the danger of a too strong grain growth and of grain boundary inter-granular carbide precipitation.
- The presence of numerous manganese sulfides (MnS) inclusions can lead to a more difficult warm forming.
- The presence of numerous manganese sulfides (MnS) can lead to hot cracking.

Cold: Limited, not recommended.

Welding

- The presence of numerous manganese sulfides (MnS) inclusions can severely impair the welding operations. More info.

Annealing

Soft anneal: 750 – 830°C, slow cooling 30°C/h down to 600°C, then air cooling
Softening anneal: 650 – 760°C, air cooling
Intermediary annealing during cold working: preferably 650 – 680°C, air cooling

- Minimum reduction: ≥ 10 – 15%, to avoid an excessive grain growth

Quenching

Primary quench: 1000-1050°C / oil, or fast air, or gas cooling
Optional: secondary quench 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 controlled cooling to avoid cracking.

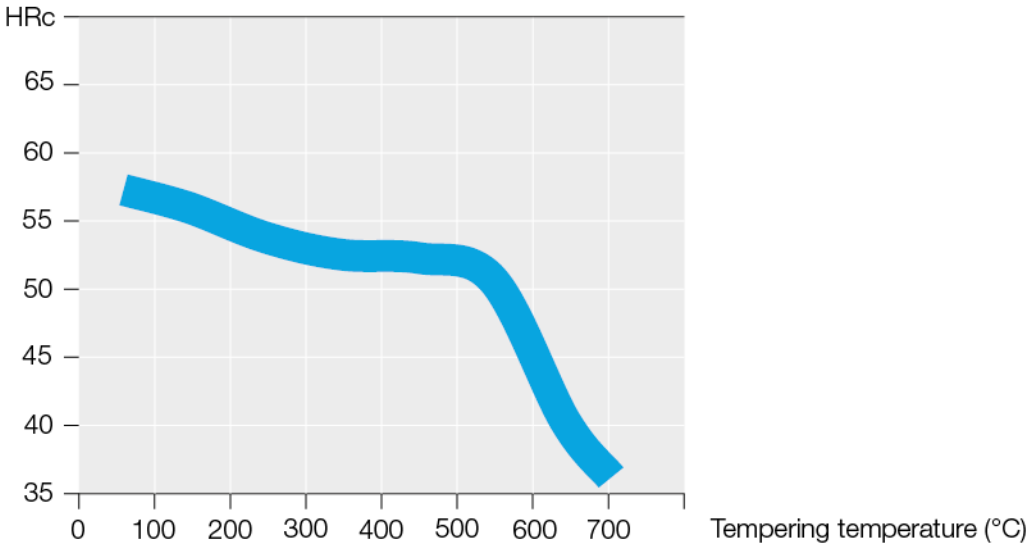
- To obtain the best efficiency, the secondary quench must be made without delay after the primary one. More info.

Tempering

Tempering according to needs, see Tempering diagram

- Not recommended in the temperature range 400 – 580°C, (brittleness range)
Not advisable because of the increased risk of intergranular corrosion.

Tempering diagram



CHRONIFER® Labor M-13

1.4034+S/AISI 420F - Martensitic free machining stainless steel

Microstructures

Delivery condition: “annealed“ and “annealed + cold drawing“ Ferrite + carbides
- Machining microstructure: Ferrite + carbides

Quenched and tempered condition: Martensite + carbides
- Microstructure for hard machining: Martensite or low tempered martensite

Microstructure for optimal polishing: Stress relieved martensite
- Microstructure for polishing: Stress relieved martensite - Martensite + carbides

Polishing

Optimal after low temperature tempering < 180°C
Nor adapted for mirror polish.
- The presence of numerous manganese sulfides (MnS) inclusions may considerably reduce the quality of the polishing and its yield.

Laser marking

- The presence of numerous manganese sulfides (MnS) impairs the 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

Passivation

Select pickling and passivation procedures and products well adapted for the treatment of free machining martensitic stainless steels.
- The numerous manganese sulfide (MnS) inclusions may significantly impair the quality of the passivation process. A pickling prior to passivation is highly recommended. It should not be skipped over. More info

Corrosion resistance

Optimum: Clean, quenched and tempered, fine polished, and passivized surfaces.
- The numerous inclusions of manganese sulfide (MnS) increase the sensitivity to pitting corrosion.
- Conditions to avoid: “annealed“ and “annealed+ cold deformed“. These conditions may develop an increased corrosion risk. They are not recommended for the permanent use of parts.
- The formation of oxides and scaling can strongly decrease the corrosion resistance. They should be eliminated either mechanically or chemically by pickling.

Elementary precautions

- The simplest and easiest precaution is always to keep the parts clean, free of working residues, polished, and correctly dried.
- Use only chlorine 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}	7.71	7.73			
Young Modulus E	GPa	215	205		190	
Electrical resistance	Ω mm^2 m^{-1}	0.55		0.65	0.60	
Thermal expansion	m m^{-1} K^{-1}	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C
	10^{-6}	10.5	10.9	11.5	12.0	12.3
Thermal conductivity	W m^{-1} K^{-1}	3.0				28.7
Specific heat	J kg^{-1} K^{-1}	460				
Melting range	1420 – 1465 °C					
Magnetism	Ferromagnetic, can be magnetized. More info.					