CHRONIFER® M-17 XH

Type 440XH – Martensitic stainless steel

Features and Peculiarities

The CHRONIFER® M-17 XH is a VIM clean steel. After VIM-melting it is directly atomized and processed according to the Carpenter Micro-Melt powder metallurgy process. Consequently, it exhibits a fine and even microstructure. Its 1.60% C-content procures it its excellent hardening capability up to 65 HRc. Compared to the AISI 440C steel, the 440-XH Micro-Melt has fine uniformly distributed carbides only promoting its excellent wear and dulling resistances. Its corrosion resistance is similar and equals this of the AISI 440C steel, CHRONIFER® 17C.

Uses

The CHRONIFER® M-17 XH steel is much indicated for the production of components for bearings, gears, of retaining balls for valves, medical, chirurgical and dental instruments, cutting tools, as well as nozzles, axis etc. of any types.

Standards

Material Number
EN
DIN
AISI/SAE/ASTM
ASTM
AMS 5630J
NF
JIS
UNS

Chemical composition (%wt)

C	Si	Mn	S	P	Cr	Ni	Mo	V	Fe
1.60	0.40	0.50	≤0.040	≤0.040	16.0	0.35	0.80	0.45	balance

Dimensions and Tolerances

- Bars Ø min. 4.76 mm: ISO h7-h8
- Bars Ø max. 12.70 mm: ISO h7-h8
- Out of roundness: max. ½ diameter tolerance

Other tolerances in request

Executions and Delivery conditions

Standard: 3 m (+50/0 mm) bars
- Bars Ø 4.76-12.70: hot rolled, annealed
  ground, polished
  pointed and chamfered
  Eddy current crack check accord. EN10277-1, Table 1

Other executions on request

Mechanical properties Condition: annealed

Flowstress $R_{0.2}$	UTS Strength	Elongation	Red. of area	Hardn. H_{BN}
471 MPa	864 MPa	10.2%	16.0%	230-255

Hardening capability

up to 65 HRc (average 64.4)

Availability

Standard dimensions on stock, see: Sale program

Cutting conditions

Machinability: difficult to pasable
forms long chips
Cutting speed: $V_c \approx 20$ - 30 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

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Forming

warm: forging: 950 – 1100°C, preferably >1020°C, slow cooling
Slow heating up to 850°C, then rapid up to the forming temoerature

cold: very difficult
almost not feasible, even after annealining at 750 – 825°C, slow cooling
Rm after annea: max. 760 MPa

Welding

difficult, not advisable

Annealing

soft anneal:
780 – 840°C / 2-4 Std / slow furnace cooling 30°C/Std down to 600°C

Quenching

Primary quench: 1000–1050°C, oil or air or gas rapid cooling

- Option: secondary cooling by deep cooling
- The highest hardness of up to 65 HRc can only be reach by transformation of the residual austenite by deep cooling

The secondary quench should be made as quickly as feasible after the primary quench.

- -20 down to -80°C/12 – 48h, preferably -80°C/12 – 24h
  or by cryo-traetment (cryogenic cooling):
- -196°C/6 – 12h, progressive or step by step cooling to avoid any potential thermal crackings. More info

Tempering

According to needs. See tempering diagrams

- The temperatur range 400 – 580°C should be avoided because of potential brittle-ness. Mind

Figure 1
Tempering diagram

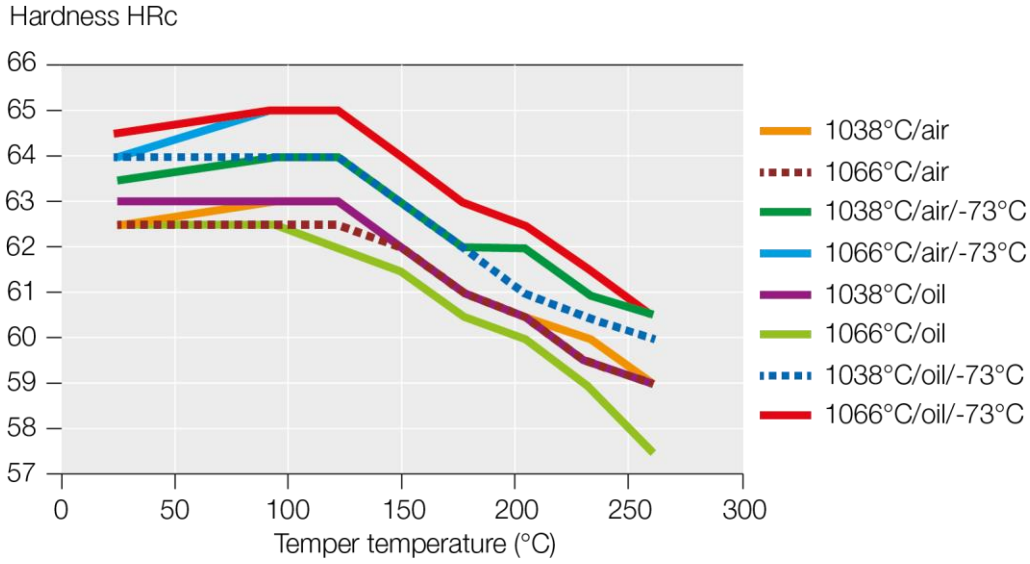

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Figure 2
Tempering diagram
Temper hardness
Quenching from
1038°C

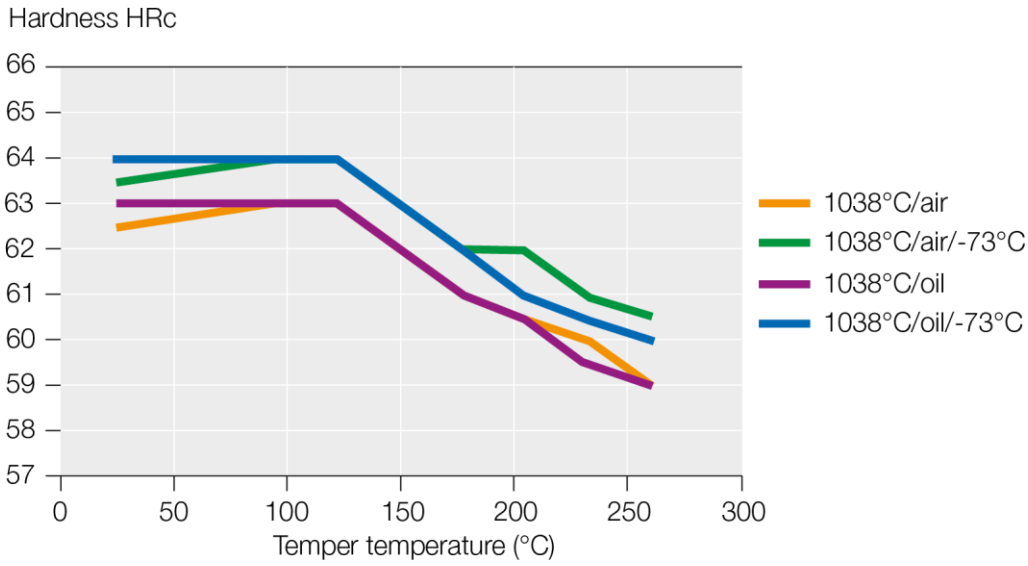
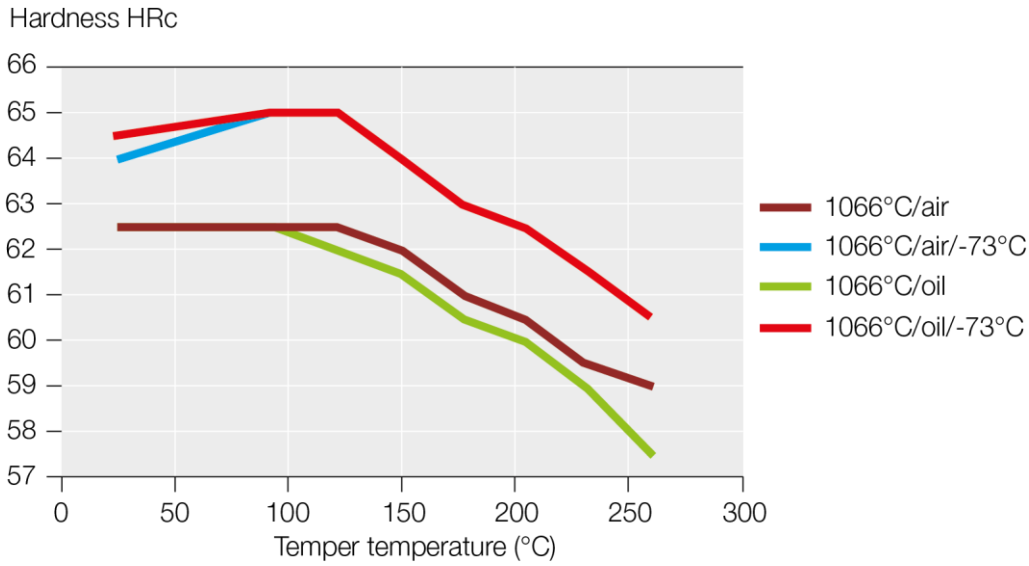


Figure 3
Tempering diagram
Temper hardness
Quenching from
1066°C



References

The numerical data of the Figures 1-5 have been published as follows:

- Improved Processing of High Alloy Steels for Wear Components in Energy Generation Systems, Transportation and Manufacturing Systems. ORNL/TM-2012/520, September 30, 2013
- Technical Data Sheet, Carpenter Stainless Type 440C, September 01, 2009
- Alloy data, Carpenter 2002

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Figure 4
Tempering diagram
Temper hardness after secondary quench

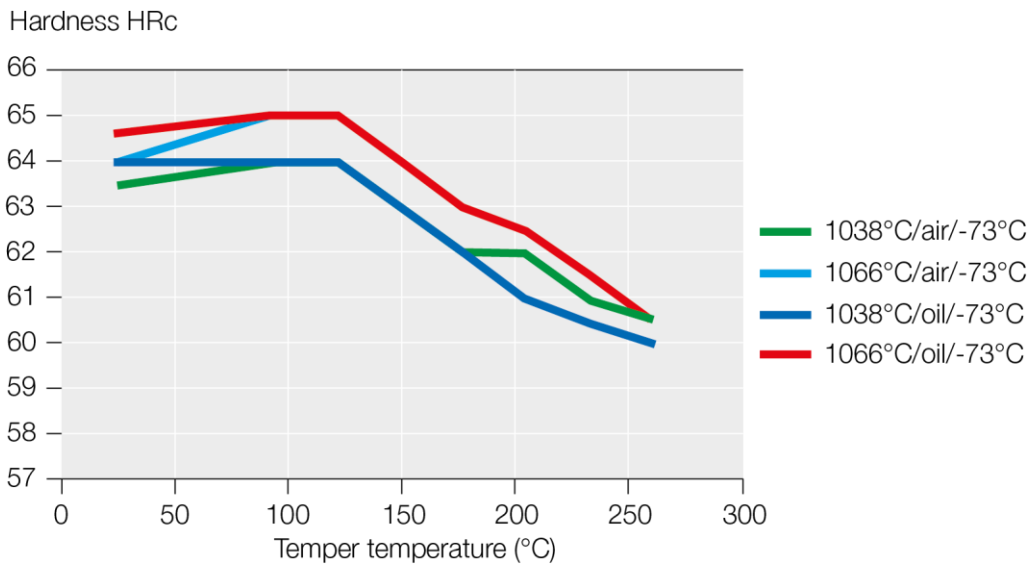
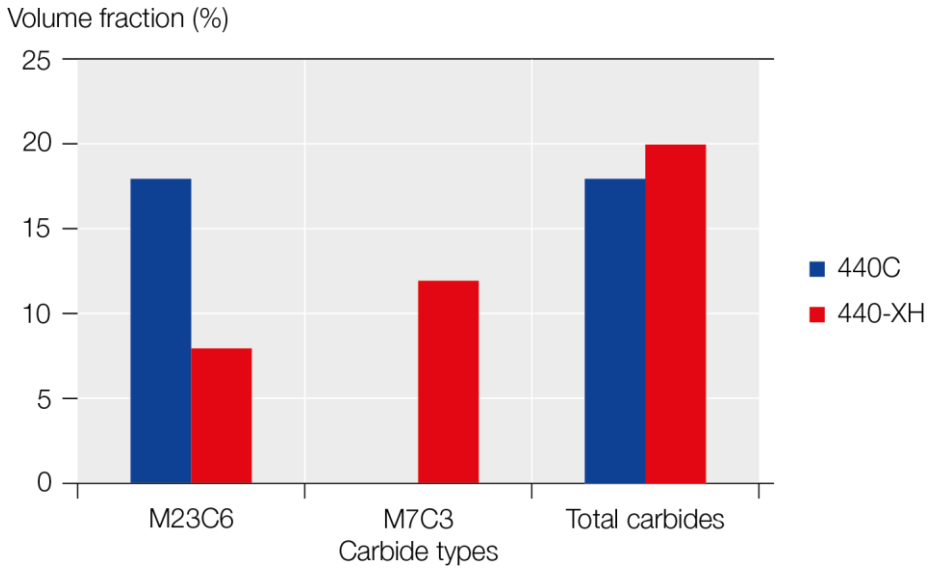


Figure 5
Carbide types



Carbide sizes

CHRONIFER® M-17 XH, 440-XH steel: max 5 µm

Heat treatment

Typical heat treatment

- Austenitisation: 1052°C/25min/oil
- Deep cooling: -73° down to -196°C/1h
  reheating to room temperature in air
- Tempering: 177°C/1h/cooling in air

Mechanical properties
Condition: annealed

- Yield stress $YS_{0.2}/R_{0.2}$: 471 MPa, 230-255 HBN
- UTS/Rm: 864 MPa
- Elongation A: 10.2 %
- Reduction of area RA: 16 %

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Microstructures

Delivery condition “annealed“: Ferrite + carbides
- Microstructure for machining dead annealed: Ferrite + carbides

Optimal microstructure for polishing: stress relieved martensite
- Microstructure for polishing: stress relieved martensite - Martensite + carbides

Polishing

Adapted for specular polishing. Strongly dependent on the presence of residual primary carbides, number, distribution and size. In case of too coarse carbides, the specular polishing could be affected.
- Optimal: after hardening and tempering

Laser marking

- The heating of the HAZ (Heat Affected Zone) can affect negatively the local microstructure and decrease its corrosion resistance. More info

Pickling and Passivation

It is strongly recommended to use pickling and passivation procedures and products adapted to the treatment of martensitic stainless steels.
- To avoid staining by “flash back“ reactions, it is also strongly recommended to pickle the surfaces before the passivation procedure. More info

Corrosion resistance

Optimal: Clean, quenched, tempered, fine polished, and passivized surfaces.
- Any formations of oxides and scaling during heat treatments can strongly decrease the corrosion resistance. These oxidations should always be eliminated, either mechanically, or chemically (by pickling).

Nitric acid	moderate	Sulfuric acid	limited
Phosphoric acid	limited	Acetic acid	limited
Natrium hydroxide	moderate	Salt Spray	limited
Humidity	good		
Mild industrial environment	resistant	Usual homekeeping environment	resistant

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 (≈AISI 440C)

Properties	Unit	Temperature (°C)				
		20	200	300	400	500
Density	g cm^{-3}	7.62				
Young modulus E	GPa	215			190	
Compression modulus	GPa	236				
Electrical resistance	Ω mm^2 m^{-1}	0.70				
Thermal elongation	m m^{-1} K^{-1}	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C
	10^{-6}	10.1	10.5	10.8	11.2	
Thermal conductivity	W m^{-1} K^{-1}	15.5				
Specific heat	J kg^{-1} K^{-1}	460				
Melting range	°C	--				
Magnetism	Ferromagnetic, can be magnetized. More info					

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