CHRONIFER® Special 71

1.4571/AISI 316 Ti – Ti stabilized austenitic stainless steel

Features and Particularities

This austenitic stainless steel is stabilized with Ti to reduce the risk of an intergranular sensitization during exposure in the temperature range 450-950°C. It occurs by forming preferentially TiC carbide instead of $Cr_{23}C_6$ Cr carbides promoting the susceptibility for intergranular corrosion. This reaction prevents the Cr depletion of the austenitic matrix, thence preserving its basic corrosion resistance and more particularly its intergranular corrosion resistance. The stabilization of the austenitic microstructure permits its continuous use of this steel up to 400°C. This steel can contain ferromagnetic ∂ (Delta) Ferrite. Its ferromagnetism can still be further enhanced by the formation α (Alpha) Martensite during cold working. It can be easily welded. The stabilizing TiC precipitates form comet tails, thence preventing the achievement of mirror polish.

Uses

This steel has a very broad field of applications. Such as the chemical, pharmaceutical, food petro- and petrochemical industries, paper pulp as well as paper industries and the colorant and textile industries. It is also use in the treatment of fresh water, its processing, transport, use and recycling.

Standards

Material number	1.4571
EN 10083-3	X6CrNiMoTi17-12-2
DIN	X6CrNiMoTi17-12-2
AFNOR	X6CrNiMoTi17-12-2 (formerly Z6 CNDT 17-12)
AISI/SAE	316 Ti
ASTM	A276
UNS	S 31635
JIS	SUS 316 Ti

Chemical composition ($\%_{wt.}$)

C	Si	Mn	P	S	Cr	Ni	Mo	N	Ti	Fe
max.	max.	max.	max.	max.	16.5	10.5	2.00	max.	>5xC	balance
0.08	1.00	2.00	0.045	0.03	18.0	13.5	2.50	0.10	<0.70	

Dimensions and Tolerances

Standard: Bars 3 m (+50/0 mm), ring for Escomatic

Mechanical properties: UTS 725-975 MPa

- Bars Ø < 1.5-16 mm: ISO h7
- Bars Ø ≥ 2.00 mm: ISO h7
- Wires Ø 0.80 - 3.00 mm: ISO fg7, ring for Escomatic
- Out of roundness max: ½ diameter tolerance

Other tolerances on request

Executions and Delivery conditions

Standard: Bars 3 m (+50/0 mm), ring for Escomatic

- Bars Ø ≥ 2.00 mm: cold drawn, ground, polished, Ra max 0.4 µm (N5)
  Ends: pointed and chamfered
- Bars < 2.00 mm: Surface condition: cold drawn
- Wires Ø < 3.00 mm: Surface condition: cold draw, ring for Escomatic

Other execution on request

Availability

Standard dimensions on stock, see: Sale program

Cutting conditions

Machinability: relatively difficult

Cutting speed: $V_c \approx >$ 40 -100 m/min,

Lubricant-coolant fluid: 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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Wear of cutting tools

The numerous TiC carbides and nitrides due to the stabilization process lead to a faster and more severe wear of the cutting tools.

Ferrite δ(Delta)

The CHRONIFER® Special 71 steel contains ∂ (Delta) Ferrite. Its Ferrite content can be determined graphically with the Schaeffler-De Long Diagram modified by Outokumpu, or computed with the aid of the Cr_{eq} und Ni_{eq} equivalent contents:

- Cr_{eq} = 1.5Si + Cr + Mo + 2Ti + 0.5Nb
- Ni_{eq} = 30(C + N) + 0.5Mn + Ni + 0.5(Cu + Co)
- Ferrite Number FN or $\%_{vol.}$ δ (Delta) Ferrite
  FN = ([{1.375 (Cr_{ew} – 16} + 10] - Ne_{il}) 2.586

Negative values of FN indicate the absence of δ (Delta) Ferrite.

PREN

- PREN = %Cr + 3.3%Mo + 18%N
- Computed basic parameters: min. 23.1 / max. 28.1

Forming

Forming: forging : Pre-heating: 1150-1180°C
Forging: 950 – 1150°C
Quenching/rapid cooling

- If the forging temperature should drop below 900°C, a preventive solution anneal is recommended to improve the following cold working if any.

Cold: no limitations

Solution anneal

1020-1080°C, quenching/rapid cooling

- A 10 – 15% cold working reduction is recommended prior to a solution anneal in order to reduce the risk of a too fast and uncontrolled grain growth.

Stabilization anneal:

- Stabilization anneal: 800-845°C
- Stress relieving anneal: 240-420°C

Hardening Strengtheing

- The CHRONIFER® Special 71 cannot be thermally hardened.
- This steel cn only be strengthenedd by cold working.

Microstructures

Delivery conditions, hot rolledd: annealed austenite
For machining and polishing: annealed or cold worked austenite

Polissing

Electropolishing: adapted, the stabilization carbides and nitrides appear in relief.

- The CHRONIFER® Special 71 is not adapted to mirror polishing.
  The stabilzation carbides and nitrides form comet tails entailing the achievement of mirror polishing.
- This steel can contain ferromagnetic ∂ (Delta) ferrite.
- The stabibilization of the microstructure by precipitation of carbides and nitrides reduce considerably the risk of formation of a σ (Sigma) phase made of complex Cr carbides. In this case a 1020-1080°C can be comtmplated in order not to compromise the corrosion resistance.
- ∂ (Delta) Ferrite and/or σ (Sigma) phases will be etched in relief by elctropolishing.

More info.

Welding

Easily feasible

Marquage laser

- The HAZ Zone (Heat Affected Zone) of the laser marking can influence negatively its local microstructure and its properties. More info.

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Surface Oxidation

Thermal oxidation forms colored oxides or scaling on the surface. These muss be eliminated, is it chemically by pickling or by mechanical means like grinding.

- Colored surface oxidation and/or scaling can massively reduce the corrosion resistance.

Pickling - Passivation

The pickling and passivation processes and the products used therefore, should always be adapted to the requirements of the pickling and passivation of austenitic stainless steels. More info.

Corrosion resistance

- Optimal surface condition: Very clean, polished and passivized. More info.

Elementary precautions

The most elementary protection is to always keep the surfaces very clean, polished and passivized.

- The parts should always be very well cleaned (no usage residual) and dried.
- Only use adapted chlorine free disinfection, cleaning and washing products.

More info.

Magnetism

Ferromagnetism due to the presence of ∂ (Delta) Ferrite:

- This steel can contain traces of ∂ (Delta) Ferrite and exhibit in the annealed condition values of its magnetic relative permeability μr >1.003.

Ferromagnetism due to the presence of α (Alpha) Martensite:

- This steel forms α (Alpha) ferromagnetic martensite during cold working. This ferromagnetism can exhibit relatively strong relative permeability values μr >2.

More info.

Phasical properties

Properties	Unit	Temperature (°C)				
		20	200	300	400	500
Density	g cm^{-3}	8.00				
Youg Modulus E	GPa	200	186	179	172	165
Poisson Coefficient		0.30				
Electrical resistance	Ω.mm^2.m^{-1}	0.74				
Thermal expansion	m m^{-1} K^{-1}	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C
	10^{-6}	16.5	17.5	18.0	18.5	19.0
Thermal conductivity	W.m^{-1}.K^{-1}	15				
Specific hest	J.kg^{-1}.K^{-1}	500				
Melting range	°C	1450-1470				
Magnetism: ∂ Ferrite	possible traces of ferromagnetic ∂ (Delta) Ferrite					
Magnetism: α Martensite	ferromagnetic cold working α Martensite					
Relative Permeability μ_r	≤1.02 in the annealed condition up to > 2 in the cold worked condition					