L.KLEIN SA
PREMIUM STEEL & METALS
SINCE 1946

AISI 316L DECOLLETAGE

≈ 1.4404 improved / AISI 316L – Austenitic stainless steel, 316L improved

Distinctive feature and main attributes

This austenitic stainless steel type 1.4404 / "AISI 316L improved" has an addition of Cu to improve its machinability as well as its corrosion resistance. Its low C content lowers the threshold temperature of its sensitization to temperature lower than 650°C. Thence ensuring its good intercristaline corrosion resistance, polishing ability and weld ability. It has a good corrosion resistance in non-oxidizing acid medium and solutions non-containing halogen elements. This steel can continuously be used up to 430°C. Its machinability is satisfactory, although superior in the cold worked condition. This CHRONIFER 316l Decolletage steel cannot be thermally hardened, but it can be strengthened by cold work. It may contain traces of ferromagnetic δ (Delta) Ferrite that may limit its finepolishing capability. Its adequacy for forming is similar to this of the 1.4435 grade, CHRONIFER® Special 35 austenitic stainless steel.

Use and application range

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; in the treatment of fresh water, its processing, transport, use and recycling; micromechanical engineering watch making industries.

Norms

Material No.	≈ 1.4404
EN 10083-3	≈ X2CrNiMo17-12-2
DIN	≈ X2CrNiMo17-12-2
AFNOR	≈ X2CrNiMo17-12-2
AISI / SAE	≈ 316L
ASTM	(F 899)
AMS	5648, 5653
JIS	SUS 316 L

Chemical composition (% wt)

C	Si	Mn	P	S	Cr
max. 0.030	max. 1.00	max. 2.00	max. 0.045	max. 0.03	16.0 – 18.0

Ni	Mo	Cu	N	Fe
10.0 – 14.0	2.00 – 3.00	max. 1.00	max. 0.10	balance

Dimensions and tolerances

Standard: Bars 3 m (+ 50 / 0 mm)
Mechanical properties UTS: 600 – 980 MPa, according to diameter
- **Bars: Ø < 10 – 40 mm:** ISO h8

Other dimensions and tolerances on request

Executions and delivery conditions

Standard: Bars 3 m (+ 50 / 0 mm)
- **Bars Ø ≥ 10 – 40 mm:** cold drawn, groundpolished, Ra max 0.8 µm,
  Bar ends: pointed and chamfered

Other executions on request

Availability

Standard dimensions on stock: see product range

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

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Cutting conditions

Machinability: satisfactory, better in the cold worked condition
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.

Grain size

According to ASTM E47:
- **Bars, hot rolled:** ASTM Nr. ≥ 6 – 7, isolated grains: > 5, according to diameter
- **Bars, cold worked:** ASTM Nr. ≥ 7 – 8

δ (Delta) Ferrite

The CHRONIFER® Special 71 steel contains δ (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:
- $Cr_{eq} = 1.5\,Si + Cr + Mo + 2\,Ti + 0.5\,Nb$
- $Ni_{eq} = 30(C + N) + 0.5\,Mn + Ni + 0.5(Cu + Co)$
- Ferrite Number FN or $\%_{vol.}$ δ (Delta) Ferrite
  $FN = [\{1.375\,(Cr_{ew} - 16\} + 10] - Ni_{il})2.586$

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

PREN

- PREN = % Cr + 3.3 % Mo + 18 % N
- **Computed basic parameters:** min. 22.6 / max. 29.7

Forming

Warm: forging: 950 – 1'100°C, quenching / rapid cooling
- If the forging temperature should drop below 900°C, a preventive solution anneal is recommended to fully recover the cold forming capability and corrosion resistance.

Cold: no limitations, see Figure 1 page 3

Annealing

Solution anneal:
- 1'040 – 1'070°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.
- The temperature range of 650 – 450°C should be avoided as it leads to sensitization and the formation and precipitation of a σ (Sigma) phase.
- The formation of σ (Sigma) phase leads to brittleness; drop of ductility and corrosion resistance.

In such case, a 1'040 – 1'070°C solution anneal is recommended.

Hardening Strengthening

- This steel cannot be thermally hardened
- This steel can be strengthened by cold working, see Figure 1, page 3

Microstructures

Delivery condition, hot rolled: annealed austenite
For machining and polishing: cold worked wires and bars: Annealed or cold worked austenite

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Polishing Adapted to all modes and techniques of polishing.
Electropolishing: adapted

- The "AISI 316L Decolletage" steel can contain traces of δ (Delta) Ferrite.
- δ (Delta) Ferrite appears in relief after electropolishing.
- In the case of the formation of a σ (Sigma) Phase or sensitization, a 1040 – 1070°C solution anneal is recommended in order to fully recover the polishing ability and capability and the corrosion resistance of this steel.
- σ (Sigma) Phase will appear in relief after electropolishing. more info

Welding Easily feasible

Figure 1
Strengthening
Cold working curves

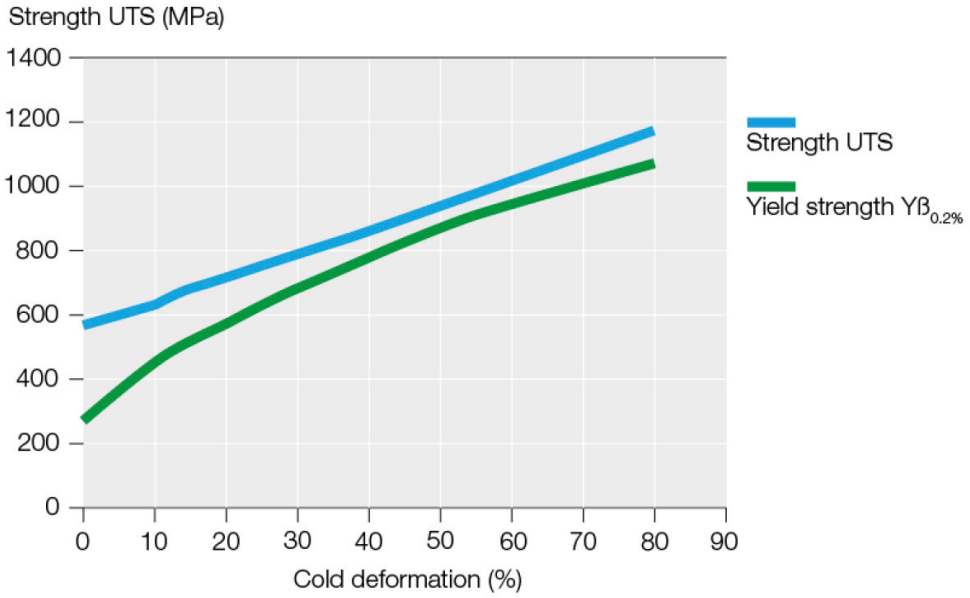

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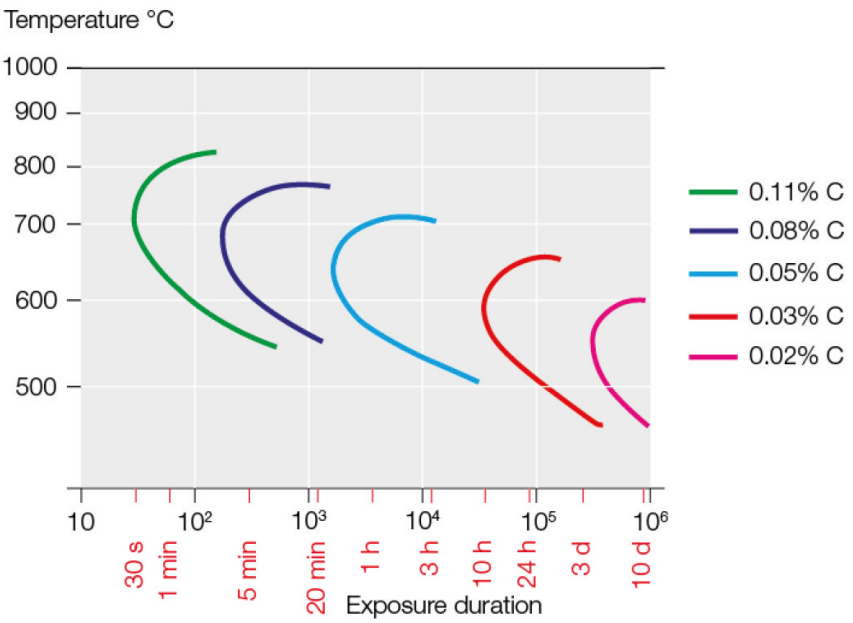
Figure 2
Sensitization TTS curves



Limitations The temperature range below 450 – 700°C should be avoided, as it may lead to sensitization of the microstructure of this steel through the formation of intergranular precipitates, which weaken it and reduce its corrosion resistance. In this case, a solution annealing treatment at 1040 – 1080°C is recommended.

Lasermarking The HAZ Zone (Heat Affected Zone) of a normal lasermarking should not significantly influence its local microstructure. more info

Superficial oxidation A 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 and 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

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Corrosion resistance

Optimal surface condition: Very clean surface, polished and passivized. more info
The indicative corrosion resistance of the "AISI 316L Decolletage" steel in various typical medium prevailing in the use of watch exterior components are given in the following table.

Type of corrosion	*Condition*	*Corrosion resistance*
Pitting corrosion	all	small at middle to long-term
Salt spray	all	medium at long term
Seawater	all	medium at long term
Stress corrosion cracking	annealed	small
	cold worked	small at middle term

Galvanic corrosion

This stainless steel is less noble than the CHRONIFER® Special 35 and Special 35 P Grades. Therefore, in particular assembly configuration with these steels in contact with an electrolytic medium, such as watch exterior assemblies, this "AISI 316L Decolletage" steel grade could be subjected to galvanic corrosion.

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.

Magnetism

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

- This steel can contain small traces of δ (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 can form α (Alpha) ferromagnetic martensite after heavy cold working. This ferromagnetism can exhibit relatively strong relative permeability values μr > 1.005. more info

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Physical properties

Properties	Unit	Temperature (°C)				
		20	200	300	400	500
Density	g cm^{-3}	7.98				
Modulus of elasticity E	GPa	200	186	179	172	165
Shear modulus G*	GPa	117				
Poisson coefficient V		0.27 – 0.28				
Electrical resistance	Ω mm^2 m^{-1}	0.75				
Thermal expansion	m m^{-1} K^{-1} 10^{-6}	20 – 100°C 16	20 – 200°C 16.5	20 – 300°C 17	20 – 400°C 17.5	20 – 500°C 18
Wärme Leitfähigkeit	W m^{-1} K^{-1}	15			15.2	
Specific heat	J kg^{-1} K^{-1}	500				
Range of melting	1'375 – 1'400°C					
Magnetism annealed	traces of δ (Delta) Ferrite **Relative Permeability:** ≥1.003					
Magnetism heavy cold deformed	traces of α (Alpha) Martensite **Relative Permeability:** > 1.005					

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