CHRONIFER® Special D 18/8

1.4305/AISI 303 – Free machining 18/8 austenitic stainless steel

Features and particularities

This steel belongs to the free machining austenitic stainless steels group. It contains 0.15-0.35% S and up to 1% Cu. It is the reference free machining austenitic stainless steel. But its high S-content reduces markedly its aptitude to welding, high quality polishing and corrosion resistance. Its high Cu-content can render it sensitive to stress corrosion cracking, and its high C-content to intergranular corrosion, after exposure in the critical sensitization range 450-850°C. It can retain traces of ∂ (Delta) ferrite in all conditions and therefore displays traces of ferromagnetism. Plastic cold deformation lead to the formation of α (Alpha) martensite and increases considerably its ferromagnetism up to relative magnetic permeability >1.

Uses

This steel is the classical free machining austenitic stainless steel. Its uses are numerous, from sanitary wares to beverage, food and chemical industries as well as components in micro-mechanical engineering and equipment.

Standards

Material Number	1.4305
ISO	7153-1 (N)
EN 10088-3	X8CrNiS 18-9
UNS	S30300
DIN | AFNOR	X8CrNiS 18-9
AISI/SAE	303
ASTM	F 899 | A 582
JIS	SUS 303

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

C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N	Fe
max.	max.	max.	max.	0.15	17.0	8.00	≤ 0.70	max.	max.	balance
0.10	1.00	2.00	0.045	0.35	19.0	10.00		1.00	0.10	

Dimensions and tolerances

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

Mechanical properties: Rm 650-950 MPa

- Bars Ø < 0.8-18 mm: ISO h8
- Bars Ø ≥ 2.00 mm: ISO h6 (h7)
- Wires Ø ≥ 0.80 - 3.00 mm: ISO fg7, coils for Escomatic
- Out of roundness max: ½ 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 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 drawn, coils for Escomatic

Other executions on request

Availability

Standards dimension on stock, see: Sale program

Cutting conditions

Machinability: very good, reference

Cutting speed: V_c ≈ 40 - 100 m/min.
Well adapted to high cutting speeds

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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Grain size

According to ASTM E47:
- Hot rolled bars: ASTM Nr. ≥ 6-7, individual grains > 5
- Cold drawn wires: ASTM Nr. ≥ 7-8

δ (Delta) Ferrite

The CHRONIFER® Special D 18/8 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.

Forming

Warm, forging 950 – 1100°C, quenching/rapid cooling
- The numerous MnS inclusions increase the hot cracking risk and restrict the hot forming capability.
- In case that the temperature should drop below 900°C, the risk of sensitization increases strongly, see Figure p. 3. In this case, a solution anneal is recommended.

Cold: feasible, see Figure 1 p. 3.

Solution anneal

1030-1060°C, quenching/rapid cooling
- To restrict the risk of a rapid and intensive grain growth, a minimum cold deformation of 10 – 15% is recommended.
- Temperature below 900°C should be avoided as they may lead to sensitization and to the precipitation of intergranular carbides. In this case, a 1030-1060°C solution anneal is recommended.

Stress relieving

- Stress relieving treatments above 150°C may lead to a drop of the mechanical properties obtained by cold deformation.

Hardening
Strengthening

- This steel cannot be hardened by heat treatment.
- This steel can be strengthened by cold deformation.

Microstructures

Delivery condition, hot worked: Austenite in the annealed condition
For machining and polishing: Cold deformed bars and wires:
Austenite in the annealed and cold worked condition

Polishing

- The presence of numerous MnS inclusions as well as of ∂ (Delta) Ferrite, may reduce significantly the steel aptitude to polishing.

Electro-polishing: adapted, with restriction
- The traces of ∂ (Delta) Ferrite present in this steel are etched in relief by electro-polishing.
- The presence of intergranular carbides after a sensitization below 850°C, requires a 1030-1060°C solution anneal treatment in order to not jeopardize the polishing abilities and corrosion resistance of this steel.
- The intergranular carbides precipitated during a sensitization exposure appears in relief after electro-polishing.

More info.

Welding

- Not recommended. The presence of numerous MnS inclusions in this steel restrict its welding.

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Figure 1
Strengthening curves

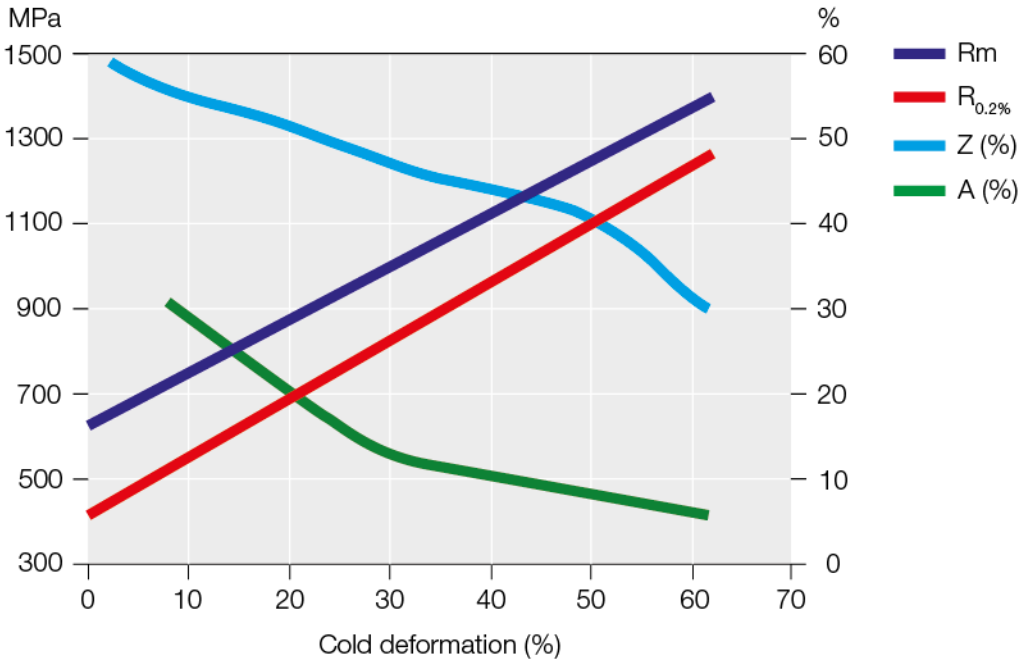
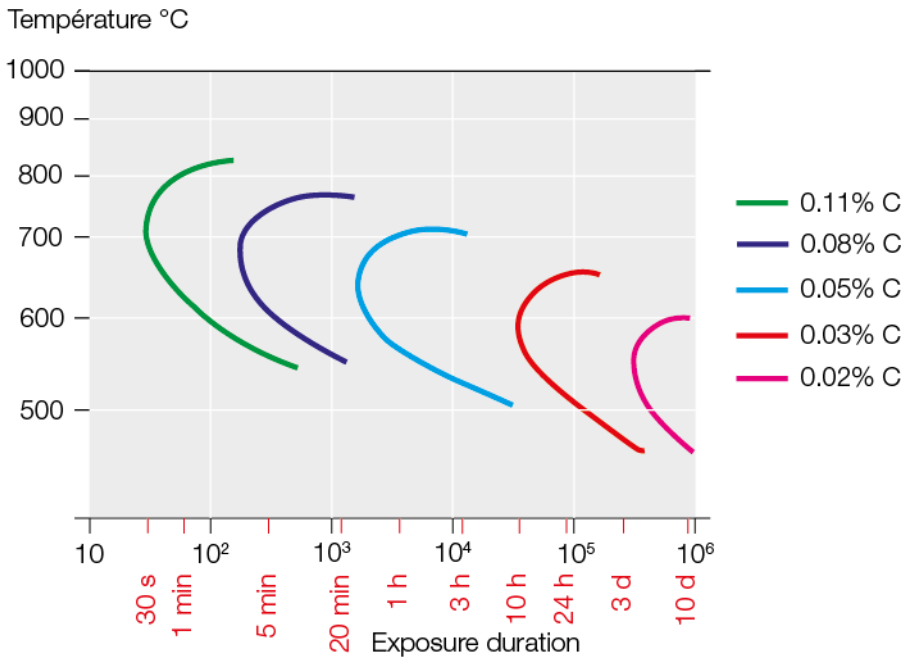


Figure 2
Sensitization
TTS curves



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Laser marking

- The numerous MnS inclusions can make the laser marking more difficult.
- The HAZ Zone (Heat Affected Zone) of the laser marking can negatively influence its local microstructure.

Laser marking: More info.

Surface 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 and jeopardize it.
- Colored surface oxidation and/or scaling can jeopardize 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 free machining austenitic stainless steels.

- Potential “Flash back“ reactions staining the surface can always be avoided by pickling the surfaces prior to passivation.
- The ferromagnetism of this steel in the cold worked condition can enhance the tendency to form flash back reactions. A pickling should always be preventively be made.
- An additional passivation treatment is not needed after electro-polishing.

More info.

PREN

- The use of computed PREN (Pitting Resistance Equivalent Number) as indicators of the pitting corrosion resistance of free machining stainless steels containing S additions are not valid, as is the case of this CHRONIFER® Special D 18/8 austenitic free machining stainless steel.

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 >1.

More info.

Use limits

Figure 2 shows the TTT sensitization curves applying for this austenitic stainless steel class. This steel can during exposure in the 450 et 850°C temperature range precipitates grain boundary carbides - intergranular carbides. This carbide precipitation reduce its corrosion resistance and increase its brittleness.

- The high C content of ≤ 0.10% of the CHRONIFER® Special D 18/8 steel renders it sensitive to this type of precipitation in the temperature range of 450-850°C, and limit its continuous use to temperature of max. 400°C.

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Physical properties

Properties	Unité	Température (°C)				
		20	200	300	400	500
Density	g cm^{-3}	7.90				
Young modulus E	GPa	200	186	179	172	
Shear modulus G*	GPa	80				
Poisson coefficient ν		0.24	0.256			
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
Thermal conductivity	W.m^{-1}.K^{-1}	15	16.3		15.2	
Specific heat	J.kg^{-1}.K^{-1}	500	510			
Liquidus	°C		1410			
Magnetism	Annealed condition: Traces of ferromagnetic ∂ (Delta) Ferrite Cold worked condition: Traces of ferromagnetic ∂ (Delta) Ferrite and α (Alpha) martensite					