ThyssenKrupp Materials International

Austenitic Corrosion Resisting Steel

Material Data Sheet

Steel Designation:	Name	Material No.
	X5CrNi18-10	**1.4301**

Scope

This data sheet applies to hot and cold-rolled sheets and strips, semi-finished products, rods, wire, sections and bright products.

Application

This material is used for fabrication and converting of food; machines for the fabrication, warehousing and transportation of milk, beer, wine and other beverages; kitchen ware, cutlery and dishes; pipes and covering for facades; door and window frames.

In delivery condition, the steel is resistant to **intergranular corrosion**; in welded condition with higher product thicknesses, depending on the chosen welding-process, the resistance cannot be guaranteed.

Chemical composition (heat analysis in %)

Product form	C	Si	Mn	P	S	N	Cr	Ni
C, H, P	≤ 0.07	≤ 1.00	≤ 2.00	≤ 0.045	≤ 0.015[1]	≤ 0.11	17.50 - 19.50	8.00 - 10.50
L	≤ 0.07	≤ 1.00	≤ 2.00	≤ 0.045	≤ 0.030[1]	≤ 0.11	17.50 - 19.50	8.00 - 10.50
T_W	≤ 0.07	≤ 1.00	≤ 2.00	≤ 0.045[2]	≤ 0.015[2]	≤ 0.11	17.00 - 19.50	8.00 - 10.50
T_S	≤ 0.07	≤ 1.00	≤ 2.00	≤ 0.040	≤ 0.015[3]	≤ 0.11	17.00 - 19.50	8.00 - 10.50

C = cold-rolled strip; H = hot-rolled strip; P = hot-rolled sheet; L = semi-finished products, rods, wire and sections;
T_W = welded tubes; T_S = seamless tubes

1) Particular ranges of sulphur content may provide improvement of particular properties. For machinability a controlled sulfur content of 0.015 % to 0.030 % is recommended and permitted. For weldability, a controlled sulfur content of 0.008 % to 0.030 % is recommended and permitted. For polishability, a controlled sulfur content of 0.015 % max. is recommended.

2) For tubes, which are welded without filler metals, P + S 0.040 % max.

3) A regulated sulfur content of 0.015 – 0.030 % has to be agreed for products, which have to be processed.

Mechanical properties at room temperature in solution annealed condition

Product form	Thickness	0,2 %	1 %	Tensile strength	Elongation		Impact energy (ISO-V) Room temperature ≥ 10 mm thick	
		Yield strength						
	mm_{max}	$R_{p0,2}$ N/mm^2_{min}	$R_{p1,0}$ N/mm^2_{min}	R_m N/mm^2	A[1] $\%_{min}$ (longitudinal)	A[1] $\%_{min}$ (transverse)	J_{min} (longitudinal)	J_{min} (transverse)
C	8	230[3]	260[3]	540 - 750[3]	-	45	-	-
H	13,5	210[3]	250[3]	520 - 720[3]	-	45	100	60
P	75	210[3]	250[3]	520 - 720[3]	-	45	100	60
L	160	190[4]	225[4]	500 - 700[4]	45	-	100	-
L	250[2]	190[5]	225[5]	500 - 700[5]	-	35	-	60
$T_{W/S}$	60	195[6]	230[6]	500 - 700[6]	40	35	100	60[7]

1) gauge length and thickness according to DIN EN
2) > 160 mm
3) transverse test piece, with product widths < 300 mm longitudinal test piece
4) longitudinal test piece
5) transverse test piece
6) longitudinal test piece, external diameter > 508 mm transverse test piece
7) > at room temperature and at -196 °C

Reference data for some physical properties (for guidance only)

Density at 20 °C kg/dm³	Modulus of elasticity kN/mm² at 20 °C	200 °C	400 °C	500 °C	Thermal conductivity at 20 °C W/m K	Specific thermal capacity at 20 °C J/kg K	Specific electrical resistivity at 20 °C Ω mm²/m
7,9	200	186	172	165	15	500	0,73

Mean coefficient of thermal expansion 10^{-6} K^{-1} between 20 °C and

100 °C	200 °C	300 °C	400 °C	500 °C
16,0	16,5	17,0	17,5	18,0

Guidelines on the temperatures for hot forming and heat treatment[1)]

Hot forming		**Heat treatment +AT (solution annealed), Microstructure**		
Temperature °C	Type of cooling	Temperature °C[2)3)4)]	Type of cooling	Microstructure
1150 to 850	air	1000 to 1100	water, air[5)]	Austenite with a low content of ferrite

1) For simulative heat treated test pieces the temperatures for solution annealing have to be agreed.

2) Solution annealing is in applicable, if the conditions for the hot forming and the concluding cooling are in such a way that the requirements for the mechanical properties of the product can be maintained.

3) If heat treatment is carried out in a continuous annealing furnace, usually the upper area of the mentioned temperature range is preferred or even exceeded.

4) For heat treatment within subsequent processing, the lower area of the stated temperature range for solution annealing has to be aspired, as otherwise the mechanical properties could be affected. If the lower limit for the solution annealing temperature was not undercut during hot forming, while repeating annealing a temperature of 980 °C as the lower limit is sufficient.

5) Cooling sufficiently rapid in order to avoid the occurrence of intergranular corrosion as defined in EN ISO 3651-2.

Processing / welding

For these steel types can be considered the following welding processions:

- TIG-welding
- MAG-welding solid wire
- Arc welding (E)
- Submerged-arc-welding (SAW)
- Laser beam welding

Process	**Filler metal**						
	similar			higher alloyed			
TIG	Thermanit JE-308L		1.4316	Thermanit H-347		1.4551	
MAG solid wire	Thermanit JE-308L Si		1.4316	Thermanit H Si		1.4551	
Manual arc (E)	Thermanit JE Special Thermanit JEW 308L-16		1.4316 1.4316	Thermanit HE Special		1.4551	
SAW	Wire	Powder		Wire	Powder		
	Thermanit JE-308L	Marathon 431 Marathon 213		Thermanit H 347	Marathon 431 Marathon 213		
Laser beam welding	See page 3						

When choosing the filler metal, the corrosion stress has to be regarded, as well. The use of a higher alloyed filler metal can be necessary due to the cast structure of the weld metal.

A preheating is not necessary for this steel. A heat treatment after welding is normally not usual.

Austenitic steels only have 30 % of the thermal conductivity of non-alloyed steels. Their fusion point is lower than that of non-alloyed steel, therefore austenitic steels have to be welded with lower heat input than non-alloyed steels. To avoid overheating or burn-thru of thinner sheets, higher welding speed has to be applied.

Copper back-up plates for faster heat reduction are functional, whereas, to avoid cracks in the solder metal, it is not allowed to surface-fuse the copper back-up plate.

This steel has an extensively higher coefficient of thermal expansion as non-alloyed steel. In connection with a worse thermal conductivity, a greater distortion has to be expected.

When welding 1.4301 all procedures, which work against this distortion (e. g. back-step sequence welding, welding alternately on opposite sides with double-V butt weld, assignment of two welders when the components are accordingly large) have to be respected notably. For product thicknesses over 12 mm the double-V butt weld has to be preferred instead of a single-V butt weld. The included angle should be 60° - 70°, when using MIG-welding about 50° are enough. An accumulation of weld seams should be avoided. Tack welds have to be affixed with relatively shorter distances from each other (significantly shorter than these of non-alloyed steels), in order to prevent strong deformation, shrinking or flaking tack welds. The tacks should be subsequently grinded or at least be free from crater cracks.

1.4301 in connection with austenitic weld metal and too high heat input the addiction to form heat cracks exists. The addiction to heat cracks can be confined, if the weld metal features a lower content of ferrite (delta ferrite). Contents of ferrite up to 10 % have a favorable effect and do not affect the corrosion resistance generally. The thinnest layer as possible have to be welded (stringer bead technique) because a higher cooling speed decreases the addiction to hot cracks.

A preferably fast cooling has to be aspired while welding as well, to avoid the vulnerability to intergranular corrosion and embrittlement.

1.4301 is very suitable for **laser beam welding** (weldability A in accordance with DVS bulletin 3203, part 3). With a welding groove width smaller 0,3 mm respectively 0,1 mm product thickness the use of filler metals is not necessary. With larger welding grooves a similar filler metal can be used. With avoiding oxidation within the seam surface during laser beam welding by applicable backhand welding, e. g. helium as inert gas, the welding seam is as corrosion resistant as the base metal. A hot crack hazard for the welding seam does not exist, when choosing an applicable process.

1.4301 is also suitable for **laser beam fusion cutting** with nitrogen or flame cutting with oxygen. The cut edges only have small heat affected zones and are generally free of micro cracks and thus are well formable. While choosing an applicable process the fusion cut edges can be converted directly. Especially, they can be welded without any further preparation.

While processing only stainless tools like steel brushes, pneumatic picks and so on are allowed, in order to not endanger the passivation.

It should be neglected to mark within the welding seam zone with oleigerous bolts or temperature indicating crayons.

The high corrosions resistance of this stainless steel is based on the formation of a homogeneous, compact passive layer on the surface. Annealing colors, scales, slag residues, tramp iron, spatters and such like have to be removed, in order to not destroy the passive layer.

For cleaning the surface the processes brushing, grinding, pickling or blasting (iron-free silica sand or glass spheres) can be applied. For brushing only stainless steel brushes can be used. Pickling of the previously brushed seam area is carried out by dipping and spraying, however, often pickling pastes or solutions are used. After pickling a carefully flushing with water has to be done.

Remark

In quenched condition the material can be slightly magnetizable. With a rising cold forming, the magnetizability increases.

According to DIN EN 10095, Appendix D material 1.4301 is deemed to be heat resisting.

Editor

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Reference

DIN EN 10088-2:2005-09	Beuth Verlag GmbH, Post box, D10772 Berlin
DIN EN 10088-3:2005-09	
DIN EN 10216-5:2004-11	
DIN EN 10217-7:2005-05	
MB 821 "Properties"	Informationsstelle Edelstahl Rostfrei, Post box 10 22 05,
MB 822 "The converting of stainless steel"	D-4013 Düsseldorf
DVS data sheet 3203, part 3	Verlag für Schweißen und Verwandte Verfahren DVS Verlag GmbH, Postfach 10 19 65, D-4010 Düsseldorf
Laser beam electric arc cutting of stainless steels	Thyssen Lasertechnik GmbH, Aachen

Laser beam – longitudinal welding of profiles of stainless steel
Böhler Schweisstechnik Deutschland GmbH, Hamm

Important note

Information given in this data sheet about the condition or usability of materials respectively products are no warranty for their properties, but act as a description.

The information, we give on for advice, comply to the experiences of the manufacturer as well as our own. We cannot give warranty for the results of processing and application of the products.