ThyssenKrupp Materials International

Austenitic Corrosion Resisting Steel

Material Data Sheet

Steel Designation:	Name	Material No.
	X6CrNiMoTi17-12-2	**1.4571**

Scope

This data sheet applies for hot and cold rolled sheet and strip, semi-finished products, bars rods, wire and sections as well as for seamless and welded tubes for pressure purposes.

Application

construction encasement, doors, windows and armatures; off shore modules; container and tubes for chemical tanker; warehouse and land transportation of chemicals, food and beverages; pharmacy, synthetic fiber, paper and textile plants; pressure vessels.

Due to the Ti-alloy, resistance to **intergranular corrosion** is guaranteed after welding.

Chemical composition (heat analysis in %)

Product form	C	Si	Mn	P	S	Cr	Mo	Ni	Ti
C, H, P	≤ 0,08	≤ 1,00	≤ 2,00	≤ 0,045	≤ 0,015[1)]	16,50 - 18,50	2,00-2,50	10,50 - 13,50	5xC bis 0,70
L	≤ 0,08	≤ 1,00	≤ 2,00	≤ 0,045	≤ 0,030[1)]	16,50 - 18,50	2,00-2,50	10,50 - 13,50[2)]	5xC bis 0,70
T_W	≤ 0,08	≤ 1,00	≤ 2,00	≤ 0,045[3)]	≤ 0,015[3)]	16,50 - 18,50	2,00-2,50	10,50 - 13,50	5xC bis 0,70
T_S	≤ 0,08	≤ 1,00	≤ 2,00	≤ 0,040	≤ 0,015[1)]	16,50 - 18,50	2,00-2,50	10,50 - 13,50[2)]	5xC bis 0,70

C = cold rolled strip; H = hot rolled strip; P = hot rolled sheet; L = semi-finished products, bars rods, wire and sections;

T_W = welded tubes; T_S = seamless tubes

1) For machinability a controlled sulfur content of 0.015-0.030 % is recommended and permitted.

2) If it should be necessary to minimize the content of delta ferrite, the maximum content of nickel can be raised by 0,5 %.

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

Mechanical properties at room temperature (in solution annealed condition)

Product form	Thick-ness	0,2 %	1 %	Tensile strength	Elongation		Impact energy (ISO-V)	
		Yield strength					Room temperature ≥ 10 mm thick	
	mm_{max}	$R_{p0,2}$ N/mm²$_{min}$	$R_{p1,0}$ N/mm²$_{min}$	R_m N/mm²	A[1)] $\%_{min}$ (longitudinal)	A[1)] $\%_{min}$ (transverse)	J_{min} (longitudinal)	J_{min} (transverse)
C	6	240[3)]	270[3)]	540 - 690[3)]	-	40	-	-
H	12	220[3)]	260[3)]	540 - 690[3)]	-	40	90	60
P	75	220[3)]	260[3)]	520 - 670[3)]	-	40	90	60
L	160	200[4)]	235[4)]	500 - 700[4)]	40	-	100	-
L	250 [2)]	200[5)]	235[5)]	500 - 700[5)]	-	30	-	60
T_W	60	190[6)]	225[6)]	490 - 690[6)]	35	30	100	60[8)]
T_S[7)]	60	190[6)]	225[6)]	490 - 690[6)]	35	30	100	60[8)]

1) Gauge length and thickness according to DIN EN

2) >160 mm

3) Transverse test piece, with product widths < 300 mm long. test piece

4) Longitudinal test piece

5) Transverse test piece

6) Longitudinal test piece, external diameter >508 mm trans. test piece

7) hot-finished

8) 60 J also at -196 °C

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Reference data on some physical properties (for guidance only)

Density at 20 °C kg/dm³	Modulus of elasticity kN/mm² at				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
	20 °C	200 °C	400 °C	500 °C			
8,0	200	186	172	165	15	500	0,75

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

100 °C	200 °C	300 °C	400 °C	500 °C
16,5	17,5	18,0	18,5	19,0

Guidelines for 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	1030 to 1110	Water, air	Austenite with a few shares 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 1000 °C as the lower limit is sufficient.

Processing / Welding

Standard welding processes for this steel grade are:

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

Process	**Filler metal**			
	similar		higher alloyed	
TIG	Thermanit A 1.4576 Thermanit GE-316L 1.4430		Thermanit 19/15 1.4455	
MAG sold wire	Thermanit A Si 1.4576 Thermanit GE-316L Si 1.4430		Thermanit 19/15 1.4455	
Arc welding (E)	Thermanit A Spezial 1.4576 Thermanit AW 1.4576 Thermanit GE Spezial 1.4430 Thermanit GEW/F 1.4430 Thermanit GEW 316L-17 1.4430		Thermanit 19/15 1.4455 Thermanit 19/15W 1.4455	
SAW	Wire	Powder	Wire	Powder
	Thermanit A	Marathon 431 Marathon 213	Thermanit 19/15	Marathon 104 Marathon 213
	Thermanit GE – 316 L	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 steels 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 rejection 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 1.4571all 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.

1.4571 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.

1.4571 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.

1.4571 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 increasing cold forming the magnetizability increases.

Editor

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References

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Important note

Information given in this data sheet about property or applicability of materials respective products are no assurance of characteristics but serve for description.

Information, with which we like to advise you, relate to the experience of the producers and our own. Warranty for the results of the treatment and application of the products cannot be granted.