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Stainless Steel 1.4401 — Material Data Sheet

This data sheet applies to hot and cold-rolled sheets/plates and strip, semi-finished products, rods, rolled wire and profiles as well as seamless and welded tubes and pipes for pressure purposes.

Application

Construction encasemnt, doors, windows and armatures, off-shore technology, cisterns and tubes for chemical tankers, production, warehousing and overland transport of chemicals, food and beverages.
Due to the Mo-content, good resistance against media containing chlorides and non-oxidising acids. The resistance to intergranular corrosion is guaranteed for larger product thicknesses in the welded condition.

Chemical Composition (heat analysis in %)[a)]

C	Si	Mn	P	S	N	Cr	Mo	Ni
0.07	1.00	2.00	0.045	0.015[1)]	0.1	16.50 - 18.50	2.00 - 2.50	10.00 - 13.00

[a)] Maximum value unless otherwise stated
[1)] For machinability a controlled sulphur content of 0.015 - 0.030% is recommended and permitted.

Mechanical Properties (at room temperature in solution annealed condition)

Product Form	Thickness mm max.	Yield Strength		Tensile Strength	Elongation		Impact energy (ISO-V) Room Temperature ≥ 10mm Thick	
		0.2%	1%					
		$R_{p0.2}$ n/mm2 min.	$R_{p1.0}$ N/mm2 min	R^m N/mm²	A[1)] % min (längs)	A[1)] % min (quer)	J min. (längs)	J min. (quer)
C	6	240[3)]	270[3)]	530 - 680[3)]	-	40	-	-
H	12	220[3)]	260[3)]	530 - 680[3)]	-	40	90	60
P	75	220[3)]	260[3)]	520 - 670[3)]	-	45	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
$T_{w/s}$	60	205[6)]	240[6)]	510 - 710[6)]	40	30	100	60

[1)] Gauge length and thickness according to DIN EN
[2)] > 160mm
[3)] Transverse test piece, with product widths < 300mm longitudinal test piece
[4)] Longitudinal test piece
[5)] Transverse test piece
[6)] Longitudinal test piece, external diameter > 508mm transverse test piece

Reference data on some physical properties

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

Linear 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 temperature 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 820	Air	1030 to 1110	Water, air	Austenite with a low content of ferrite

[1)] For simulative heat treatment 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 otheriwse 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 process for these steel grades are:

- TIG-Welding
- MAG-Welding Solid Wire
- Arc Welding (E)
- Submerged Arc Welding (SAW)
- Laser Bean Welding

Process	Filler Metal			
	Similar		Higher Alloyed	
TIG	Thermanit GE-316 L	1.4430	Thermanit A	1.4576
MAG Solid Wire	Thermanit GE-316 L Si	1.4430	Thermanit A Si	1.4576
Arc Welding (E)	Thermanit GE Special Thermanit GEW 316 L-17	1.4430 1.4430	Thermanit A Special Thermanit AW	1.4576 1.4576
SAW	Wire	Powder	Wire	Powder
	Thermanit GE-316L	Marathon 431 Marathon 213	Thermanit A	Marathon 431 - 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-through 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 1.4401 all procedures, which work against this distortion (eg. 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 12mm 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.
1.4401 is very suitable for laser beam welding (weldability A 9in accordance with DVS bulletin 3203, part 3). With a welding groove width smaller 0.3mm respectively 0.1mm product thickness the use of filler metals is not neccessary. With larger welding grooves a similar filler metal can be used. With avoiding oxidation within the seam surface during laser beam wedling by applicable backhand welding, eg. helum 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.
1.4401 is very 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 corrosion resistance of this stainless steel is based on the formation of a homogeneous, compact pasisve layer on the surface. Annealing colours, 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 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.

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Important Note