1.4016

X6Cr17

Stainless ferritic, chromium steel

C max. 0.08 **Cr** 16.00 – 18.00

General comments

Although the corrosion resistance of 1.4016 is inferior to the austenitic grades of stainless steels, its ferritic microstructure makes it resistant to the effects of stress corrosion cracking, a form of corrosion to which most of the conventional austenitic stainless steels are susceptible to. Despite this beneficial characteristic, the use of 1.4016 is limited by its poor weldability.

Relevant current and obsolete standards

EN 10088-3	1.4016	X6Cr17
AISI	430	
BS	430S17	
JIS	430	
AFNOR	Z8C17	
DIN 17440	1.4016	
SIS	2320	

Special grade for particular use

cold heading grade
cold forming grade
wire drawing grade

General properties

corrosion resistance	good
mechanical properties	average
forgeability	good
weldability	poor
machinability	average

Special properties

ferromagnetic grade
suitable for use up to 650 °C

Physical properties

density (kg/dm^3)	7.70
electrical resistivity at 20 °C (Ω mm^2/m)	0.60
magnetizability	yes
thermal conductivity at 20 °C (W/m K)	25
specific heat capacity at 20 °C (J/kg K)	460
thermal expansion (K^{-1})	20 – 100 °C: 10.0 x 10^{-6}
	20 – 200 °C: 10.0 x 10^{-6}
	20 – 300 °C: 10.5 x 10^{-6}
	20 – 400 °C: 11.0 x 10^{-6}
	20 – 500 °C: 11.0 x 10^{-6}

Typical applications

building industry
electronic equipment
mechanical engineering
decorative applications
food and beverage industry

Note: supplied in accordance with the Z-30.3-6 building regulation
dimensional limits can be agreed on

Processing properties

automated machining	seldom
machinable	seldom
hammer and die forging	yes
cold forming	yes
cold heading	yes
suited to polishing	yes

Conditions

annealed

Demand tendency

sharply rising

Corrosion resistance (PRE = 16.0 – 18.0)

As a result of its higher chromium content, 17 %, 1.4016 is more corrosion resistant than 1.4003 and other 13 % chromium stainless steels. Good corrosion resistance is displayed in moderately corrosive media/environments with low chloride ion concentrations, such as natural waters, soap and detergent solutions. It must be noted that 1.4016 is not resistant to sea water. 1.4016 is resistant to intergranular corrosion in the as-delivered condition, but is not resistant to intergranular corrosion after welding or elevated temperature forming process.

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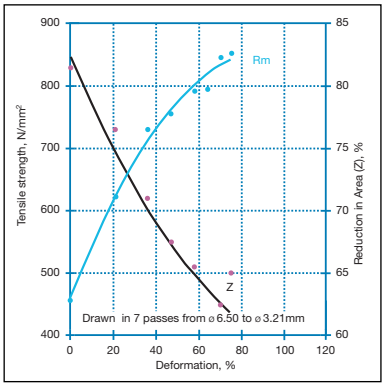
Heat treatment and mechanical properties

1.4016 may be annealed by holding in the temperature range 750 °C to 850 °C, followed by cooling in air. Since this grade of steel is prone to rampant grain growth, a temperature of 850 °C should not be exceeded. In the annealed condition, the following mechanical properties may be attained when testing in the longitudinal direction:

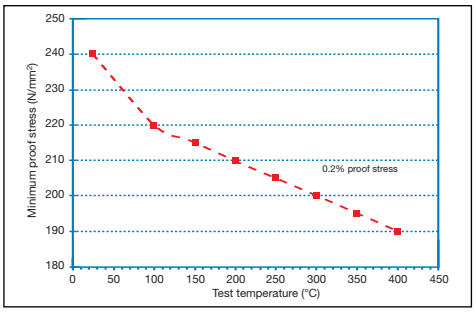
Property		Specification	Typical
yield strength (N/mm²)	$R_{p0.2}$	≥ 240	300
tensile strength (N/mm²)	R_m	400 – 630	480
tensile elongation (%)	A_5	≥ 20	28
hardness	HB	≤ 200	



A typical work hardening curve for 1.4016

The mechanical properties (d ≥ 160 mm) have to be agreed on for thicker dimensions, or the delivered product is based on the values given.

Elevated temperature properties



Minimum tensile properties at various temperatures, shown in the diagramm, are specified in the EN 10088-3.

Welding

1.4016, like most ferritic stainless steels, is prone to rampant grain growth when exposed to elevated temperatures which result in the formation of a coarse grained heat affected zone on each side of the weld bead. Since ferritic stainless steels also have a very limited solubility for interstitial elements such as carbon and nitrogen, the formation of chromium carbides and nitrides in the heat affected zone are also not uncommon. Arc welding of 1.4016 is thus not recommended. If welding is unavoidable, then the use of carbon or nitrogen containing shielding gasses must be avoided.
The detrimental effects of grain growth and formation of precipitates can be controlled to some extent by limiting the heat input during welding to less than 1kJ/mm, avoiding preheating, avoiding weaving during welding and ensuring that the workpiece is clean, i.e. free from grease, oil or any other form of hydrocarbon. Resistance and friction welds are easier to produce than arc welds. When the application of a filler metal is required, then Novonit® 4316 or Novonit® 4502, can be used.

Forging

The work-piece is usually heated to temperatures between 1100 °C and 1130 °C, with forging taking place at temperatures between 1130 °C and 750 °C followed by cooling in air.

Machining

As a result of its ferritic microstructure, 1.4016 tends to smear when machined resulting in a build-up of material on the cutting tool and the production of longer swarf. This phenomenon can be counteracted to some extent by using coated hard metal cutting/machining tools combined with adapted cutting/machining parameters. The following machining parameters can be used as a guideline when machining 1.4016.

	Depth of cut (mm)	6	3	1
	Feed rate (mm/r)	0.5	0.4	0.2
Annealed **R_m 450 – 550 N/mm²**	Cutting speed (m/min)	160	190	260

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