1.4021

X20Cr13

Chromium martensitic stainless steel

C 0.16 – 0.25 **Cr** 12.00 – 14.00

General comments

1.4021 is used in the quenched and tempered condition in a host of constructional and fastener applications where moderate corrosion resistance is required. The knife blade variant of 1.4021 can be polished to high gloss finishes. Optimal corrosion resistance is also attained when the surface is finely ground or polished.

Relevant current and obsolete standards

EN 10088-3	1.4021	X20Cr13
AISI	420	
BS	420S29 / 420S37	
JIS	420J1	
AFNOR	Z20C13	
DIN 17440	1.4021	
SIS	2303	

Special grades for particular applications

Cutlery and blade steel

General properties

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

Special properties

ferromagnetic grade
suitable for use up to 550 °C

Physical properties

density (kg/dm³)	7.70
electrical resistivity at 20 °C (Ω mm²/m)	0.60
magnetizability	yes
thermal conductivity at 20 °C (W/m K)	30
specific heat capacity at 20 °C (J/kg K)	460
thermal expansion (K^{-1})	20 – 100 °C: 10.5 x 10^{-6}
	20 – 200 °C: 11.0 x 10^{-6}
	20 – 300 °C: 11.5 x 10^{-6}
	20 – 400 °C: 12.0 x 10^{-6}

Typical applications

automotive industry
decorative applications
hydraulic equipment
petrochemical industry
food and beverage industry
mechanical engineering
cutlery and blades

Note: available from stock

Processing properties

automated machining	yes
machinable	yes
hammer and die forging	yes
cold forming	yes
cold heading	not common
suited to polishing	yes

Conditions

annealed, tempered

Demand tendency

rising

Corrosion resistance (PRE = 12.0 – 14.0)

Good corrosion resistance in moderately corrosive environments that are free of chlorides, such as soaps, detergents and organic acids. Good resistance in oxidising atmospheres up to temperatures of about 600 °C. 1.4021 is not resistant to intergranular corrosion in the as-delivered or as-welded conditions.

Heat treatment and mechanical properties

1.4021 can be soft annealed by holding at a temperature in the range 745 °C to 825 °C followed by slow cooling in air. In this condition, the following mechanical properties can be expected:

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Property		Specification
tensile strength (N/mm²)	R_m	≤ 760
hardness	HB	≤ 230

Note: the HB values could be 60 units higher and the tensile strengths 150 N/mm² higher due to cold work during straightening of profiles ≤ 35 mm.

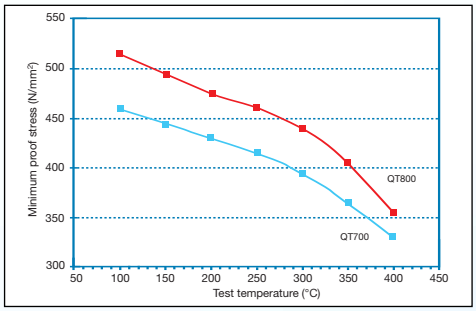
1.4021 can be hardened by holding at a temperature between 950 °C – 1050 °C followed by cooling in air or oil. The tempering temperature is dependent on the desired strength. Due to the precipitation of undesirable phases, the temperature range 400 °C to 600 °C should be avoided. Two heat treated conditions are usually specified, namely: QT700 (tempered between 650 °C and 750 °C) and QT800 (tempered between 600 °C and 700 °C). The number behind the designation QT relates to the minimum tensile strength. In these conditions, the following mechanical properties can be expected:

Property		Spec. QT700	Typical
yield strength (N/mm²)	$R_{p0.2}$	≥ 500	680
tensile strength (N/mm²)	R_m	700 – 850	830
tensile elongation (%)	A_5	≥ 13	16
impact energy (J) 25 °C	ISO-V	≥ 25	

Property		Spec. QT800	Typical
yield strength (N/mm²)	$R_{p0.2}$	≥ 600	760
tensile strength (N/mm²)	R_m	800 – 950	930
tensile elongation (%)	A_5	≥ 12	15
impact energy (J) 25 °C	ISO-V	≥ 20	

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

Preheating of the work piece to a temperature within the range 100 °C – 300 °C is required as well as a post weld tempering treatment when welding is performed using a matching filler material. Generally, Novonit® 4551 is recommended when a filler material is required. Tempering at 650 °C after welding is recommended to restore some of the ductility in the weld zone. When using an inert or protective shielding gas during welding, care must be taken to avoid use of any hydrogen or nitrogen containing gases since contamination of the weld with nitrogen or hydrogen will adversely affect the mechanical properties. After welding the work piece must be cooled to below the martensite start (M_s), temperature of approximately 120 °C before being tempered.

Forging

Gradual heating to a temperature of about 850 °C is recommended prior to more rapid heating to a temperature of between 1150 °C and 1180 °C. Forging then takes place between 1100 °C – 900 °C followed by slow cooling in an oven or in dry ash or similar material to promote slow cooling.

Machining

The machinability of this grade of stainless steel is directly related to its hardness. 1.4021 machines similar to carbon steels of the same hardness. Although it must be realised that the machining parameters will vary depending on the structure/hardness of the steel, the following parameters can be used as a guideline when machining with coated hardmetal tools:

	Depth of cut (mm)	6	3	1
	Feed rate (mm/r)	0.5	0.4	0.2
Annealed **R_m 520 – 650 N/mm²**	Cutting speed (m/min)	170	220	230
Tempered **R_m 780 – 930 N/mm²**	Cutting speed (m/min)	170	220	260

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