Material Data Sheet

Martensitic corrosion resisting steel

Materials Services
Technology, Innovation
& Sustainability

Steel designation	Name	Material No.
	X20Cr13	1.4021

Scope

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

Application

1.4021 is used in the hardened state for numerous construction and fasting elements, which have to be corrosions resistant in moderate aggressive media. The material is mainly used in the automotive industry, petroleum industry, petrochemical industry, hydraulic industry, machinery, cutlery industry and for decorative purpose and kitchen facilities.

Chemical composition (heat analysis in %)

Product form	C	Si	Mn	P	S	Cr
C, H, P	≤ 0.16 – 0.25	≤ 1.00	≤ 1.50	≤ 0.040	≤ 0,015	12.0 – 14.0
L					≤ 0,030[1)]	

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

[1)] Particular ranges of sulphur content may provide improvement of particular properties. For machinability a controlled sulphur content of 0,015 % to 0,030 % is recommended and permitted. For weldability, a controlled sulphur content of 0,008 % to 0,030 % is recommended and permitted. For polishability, a controlled sulphur content of 0,015 % max is recommended.

Mechanical properties at room temperature in solution annealed condition

Product form	Thickness mm max.	Heat treatment condition[1]	Hardness[2] max. HRB	Hardness[2] max. HB or HV	0,2% proof strength $R_{p0,2}$ N/mm²	Tensile strength[4] R_m N/mm²	Elongation[4] min. in % A_{80mm}[5] <3 mm thickness (l + t)	Elongation[4] min. in % A[6] ≥3mm thickness (l + t)	Impact energy (ISO-V) KV J l	Impact energy (ISO-V) KV J t	Hardness HRC	Hardness HV
C	3	+QT	-	-	-	-	-		-		44 - 50	440 - 530
C	8	+A	90	225	-	max. 700	15		-		-	-
H	13,5						12					
P	75	+QT650			450	650 - 850	12		by arrangement		-	
		+QT750			550	750 - 950	10					
L	-	+A	-	230[3]	-	max. 760	-	-	-	-	-	
L	≤ 160[9][10]	+QT700	-	-	500	700 - 850	-	13 (l)	25	-	-	
		+QT800	-	-	600	800 - 950	-	12 (l)	20	-	-	

[1] +A = annealed; + QT = quenched and tempered

[2] Brinell or Vickers or Rockwell hardness is normally determined for product forms C and H in heat treatment condition A. The tensile test shall be carried out in referee testing.

[3] For information only (HB)

[4] For wire rod only the tensile test values apply.

[5] Values apply for test pieces with a gauge length of 80 mm and a width of 20 mm; test pieces with a gauge length of 50 mm and a width of 12,5 mm may also be used.

[6] Values apply for test pieces with a gauge length of 5,65 $\sqrt{S_o}$.

[7] Plates may also be delivered in the annealed condition; in such cases the mechanical properties are to agreed at the enquiry and order.

[8] For thicknesses over 75 mm, the mechanical properties can be agreed.

[9] Thickness or diameter

[10] For hexagonal bars the key length.

Minimum values of the 0.2 %-Yield strength of martensitic steels at elevated temperatures

Product	Heat treatment condition [1]	0,2 %-proof strength at the temperature °C 100	150	200	250	300	350	400
		N/mm² min.						
C, H, P	+QT650	420	410	400	385	365	335	305
L	+QT700	460	445	430	415	395	365	330
	+QT800	515	495	475	460	440	405	355

[1] +QT = quenched and tempered

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
7.7	220	210	195	-	30	460	0.60

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

100 °C	200 °C	300 °C	400 °C	500 °C

10.5	11.0	11.5	12.0	12.0

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

Product form	Hot forming		Heat treatment symbol	Annealing		Quenching		Tempering
	Temperature °C	Type of cooling		Temperature[2)] °C	Type of cooling	Temperature[2)] °C	Type of cooling	Temperature °C
C, H, P	1100 - 800	slow cooling	+A	730 - 790	-	-	-	-
			+QT	-	-	950 - 1050	Oil, air	200 - 350
			+QT650	-	-	950 - 1010		700 - 780
			+QT750	-	-			620 - 700
L			+A	745 - 825	Air	-	-	-
			+QT700	-	-	950 - 1050	Oil, air	650 - 750
			+QT800	-	-			600 - 700

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

[2)] 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.

Processing/Welding

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

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

Process	Filler metal	
	similar	higher alloyed
TIG	Thermanit 14K	Thermanit Nicro82
MAG solid wire	Thermanit 14K	Thermanit Nicro82
MAG cored wire	Thermanit 14K	Thermanit Nicro82
Manual arc (E)	Thermanit 14K	Thermanit Nicro82
SAW	Thermanit 14K	Thermanit Nicro82

This steel can be weld well by all types of welding processes (except gas welding)

Usually pre-heating up to 100 – 300 °C as well as tempering after welding with a similar filler metal.

Tempering after welding at 650 °C is required, to regain a certain ductility. When welding under gas, no hydrogen of nitrogen containing gas may be used as contamination of the weld metal with nitrogen or hydrogen can affect the mechanical properties adversely.

Following the welding, the work piece has to be cooled down to a temperature below M_s, this means to a temperature of approx. 120 °C, before tempering.

Cold forming/Hot forming

Cold forming with low amount of deformation is easily feasible above room temperature. Sharp chamfers parallel to the direction of rolling have to be avoided. Sheets with greater thicknesses and/or higher amount of deformation should be preheated up to 200 - 400 °C. If applicable, a hot forming at 700 - 900 °C can be necessary.

The corrosion resistance is affected by annealing colors, which occur after hot forming or welding, or scalings.

These have to be removed by pickling (pickling solution), grinding or sand blasting. It is only allowed to use iron-free tools for these workings.

Machining

Machining does not differ from machining of non-alloy carbon steels with comparable or corresponding strength.

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Reference

DIN EN 10088-2:2014-12	Beuth Verlag GmbH, Postfach, D-10772 Berlin
DIN EN 10088-3:2014-12	
Welding filler materials	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.