1.4057

X17CrNi16-2

Chromium-martensitic stainless steel with nickel addition

C 0.12 – 0.22 **Cr** 15.00 – 17.00 **Ni** 1.50 – 2.50

General comments

1.4057 is most commonly used in applications where the 12 % chromium steels do not exhibit sufficient resistance to corrosion or when the toughness of the 12 % martensitic stainless steels is not sufficient.

Relevant current and obsolete standards

EN 10088-3	1.4057	X17CrNi16-2
AISI	431	
BS	321S31 / 431S29	
JIS	431	
AFNOR	Z15CN16-02	
DIN 17440	1.4057	
SIS	2321	
aviation and aerospace industry	WL4044	

General properties

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

Special properties

can be used to temperatures around 400 °C
ferromagnetic grade

Physical properties

density (kg/dm³)	7.70
electrical resistivity at 20 °C (Ω mm²/m)	0.70
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: 10.5 x 10^{-6}
	20 – 300 °C: 10.5 x 10^{-6}
	20 – 400 °C: 10.5 x 10^{-6}

Typical applications

automotive industry
chemical industry
aerospace industry
petrochemical industry
mechanical engineering

Note: available from stock
Employment according to the Pressure Equipment Directive 97/23/EC possible after consultation

Processing properties

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

Conditions

annealed, tempered

Demand tendency

rising

Corrosion resistance (PRE = 17.5 – 21.26)

The formation of chromium carbides and the associated chromium depleted regions that form around these precipitates make this grade of steel susceptible to intergranular corrosion. Surface condition plays an important role in the corrosion resistance of this steel with polished surfaces exhibiting far superior corrosion resistance compared with rougher surfaces on the same material.

Heat treatment and mechanical properties

1.4057 can be soft annealed by holding at a temperature in the range 680 °C to 800 °C followed by slow cooling in an oven or air. In this condition, the following mechanical properties can be expected:

Property		Specification
tensile strength (N/mm²)	R_m	≤ 950
hardness	HB	≤ 295

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.

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1.4057 can be hardened by holding at a temperature between 950 °C – 1060 °C followed by cooling in air or oil.

The tempering temperature is dependent on the desired strength. Since this grade of steel is susceptible to 475 °C embrittlement, care must be taken to limit exposure to the temperature range 420 °C to 520 °C, both during fabrication and service.

Two heat treated conditions are usually specified, namely: QT800 (tempered between 750 °C and 800 °C followed by a second tempering treatment between 650 °C and 700 °C)* and QT900 (tempered between 600 °C and 650 °C). The number behind the designation QT relates to the minimum tensile strength. In these conditions, the following mechanical properties can be expected:

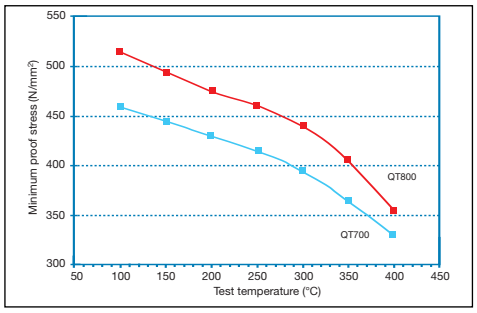
		Spec. QT800	Typical
yield strength (N/mm²)	$R_{p0.2}$	≥ 600	620
tensile strength (N/mm²)	R_m	800 – 950	820
tensile elongation (%)	A_5	≥ 14	20
impact energy (J) 25 °C	ISO-V	≥ 25	

		Spec. QT900	Typical
yield strength (N/mm²)	$R_{p0.2}$	≥ 700	710
tensile strength (N/mm²)	R_m	900 – 1050	920
tensile elongation (%)	A_5	≥ 12	16
impact energy (J) 25 °C	ISO-V	≥ 25	

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

*Should the nickel content be on the lower end of the specification, then a simple tempering treatment at a temperature between 620 °C and 720 °C will be sufficient.

Elevated temperature properties



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

Welding

When welding 1.4057 with a matching filler, the work piece is usually heated to a temperature of between 100 °C and 300 °C prior to welding and is tempered as soon as possible after welding to restore some ductility to the weld zone. For optimal properties, the entire work piece should be re-heat treated. When the mechanical properties are not of primary concern, then Novonit® 4430 or 4370 can be used as the filler material. When these two fillers are used, pre-heating of the work piece is not required. Care must be taken to ensure that no nitrogen or carbon containing gasses are used for the shielding gas since this can adversely affect the properties of the weldment. To ensure adequate corrosion resistance of the weldment, any spatter or heat tint must be removed.

Forging

Care should be taken when forging since 1.4057, since 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 1180 °C – 950 °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. 1.4057 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 using coated hardmetal cutting tools:

	Depth of cut (mm)	6	3	1
	Feed rate (mm/r)	0.5	0.4	0.2
Solution annealed R_m 700 – 800 N/mm²	Cutting speed (m/min)	100	130	165

DEUTSCHE EDELSTAHLWERKE GMBH
Auestraße 4
58452 Witten
www.dew-stahl.com

Tel. +49 2302 29 0
Fax +49 2302 29 4000
stainless@dew-stahl.com