1.3964

X2CrNiMnMoNNb21-16-5-3

Austenitic chromium-nickel stainless steel stabilised with niobium for use in non-magnetic applications.

C max. 0.03 **Mn** 4.00 – 6.00 **Cr** 20.00 – 21.50 **Ni** 15.00 – 17.00 **Mo** 3.00 – 3.50 **Nb** max. 0.25

General comments

1.3964 displays non magnetic properties due to its high alloy content. This high alloy content also results in high tensile and yield strengths coupled with very good resistance against corrosion, especially in seawater and coastal environments.

Relevant current and obsolete standards

SEW 390	1.3964	X2CrNiMnMoNNb21-16-5-3

General properties

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

Special properties

non-magnetic grade ($\mu_r \leq 1.04$)

Physical properties

density (kg/dm³)	7.90
electrical resistivity at 20 °C (Ω mm²/m)	0.70
magnetizability	no
thermal conductivity at 20 °C (W/m K)	14
specific heat capacity at 20 °C (J/kg K)	460
thermal expansion (K^{-1})	20 – 100 °C: 15.7 x 10^{-6}
	20 – 200 °C: 17.0 x 10^{-6}
	20 – 300 °C: 17.5 x 10^{-6}
	20 – 400 °C: 17.8 x 10^{-6}

Typical applications

non-magnetic components
ship building industry

Note: alternative materials 1.3952 and 1.3974

Processing properties

automated machining	no
machinable	yes
hammer and die forging	yes
cold forming	in some instances
cold heading	in some instances

Conditions

solution annealed and quenched

Demand tendency

constant

Corrosion resistance (PRE = 33.1 – 38.6)*

1.3964 displays excellent resistance against corrosion in rural, industrial and coastal environments, and can be used in the food and beverage industry, provided the acid concentrations are not too high. 1.3964 finds use in cold nitric and organic acid solutions, as well as in chloride containing environments. Since this grade of stainless steel is still resistant to intergranular corrosion after welding, i.e. in the sensitised condition, corrosion testing in accordance with the following corrosion testing specifications is thus sufficient to establish resistance to corrosion:
AFNOR NF 05-159 – ASTM A262-75. Practice E – DIN 50914

*Please note that the presence of large amounts of manganese could adversely affect the pitting corrosion resistance. This means that although this steel is resistant to corrosion in sea water, it will be less resistant to pitting corrosion than an equivalently alloyed, low manganese steel.

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Heat treatment and mechanical properties

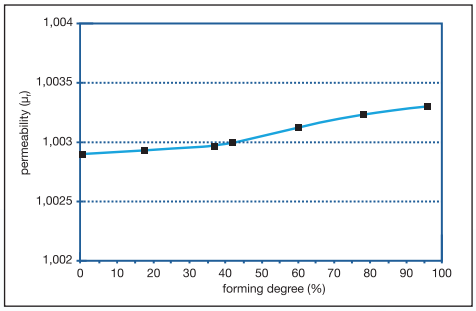
Optimal physical and fabrication properties are realised after solution annealing in the temperature range 1020 °C – 1050 °C followed by rapid cooling in air or water. In the solution annealed condition, the following mechanical properties may be attained when testing in the longitudinal direction:

Property		Specification	Typical
yield strength (N/mm²)	$R_{p0.2}$	≥ 365	560
tensile strength (N/mm²)	R_m	700 – 950	890
tensile elongation (%)	A_5	≥ 35	39
impact energy (J) 25 °C	ISO-V	≥ 85	150

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

Magnetic permeability

The low magnetic permeability of AMANOX® 3964 stems from its austenitic microstructure.



The diagram shows the variation of permeability against cold forming degree.

Welding

As a result of the low carbon content of 1.3964, welding will not result in the formation of chromium carbides. Should a filler material be required, then the grades 1.3954 and 1.3984 can be used.Should heat treatment after welding be unavoidable, due to extensive cold deformation or due to high wall thickness, then the aforementioned heat treatment may be undertaken.

Forging

When forging 1.3964, the work pieces are usually pre-heated to between 950 °C – 1150 °C with forging taking place between 900 °C and 1100 °C. After forging, the forged component must be rapidly cooled in either air or water to avoid the formation of any undesirable phases which might adversely affect the corrosion and/or mechanical properties.

Machining

As a result of its high alloying addition, 1.3964 is difficult to machine. The following machining parameters can be used as a guideline when machining 1.3964 using coated hard metal cutting tools.

	Depth of cut (mm)	6	3	1
	Feed rate (mm/r)	0.5	0.4	0.2
Solution annealed R_m 560 – 640 N/mm²	Cutting speed (m/min)	110	125	150

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