SANICRO® 70
TUBE AND PIPE, SEAMLESS

DATASHEET

Sanicro® 70 is an austenitic nickel-chromium-iron (NiCrFe) alloy characterized by very good resistance to carburization and nitrogen absorption and good structural stability at high temperatures. It also has good resistance to stress corrosion cracking (SCC).

STANDARDS

- UNS: N06600
- W.Nr.: 2.4816
- DIN: NiCr 15Fe
- BS: NA14

Product standards

- ASTM B163, B167
- BS 3074

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Cu	Fe
≤0.05	0.4	0.8	≤0.015	≤0.015	16.5	72.5	≤0.5	≤10.0

FORMS OF SUPPLY

Seamless tube and pipe

Tube and pipe are normally supplied in the solution annealed and white-pickled condition. Small sizes, e.g. heat exchanger tubes, can also be supplied in the bright-annealed condition. The principal size range is shown in figure 1.

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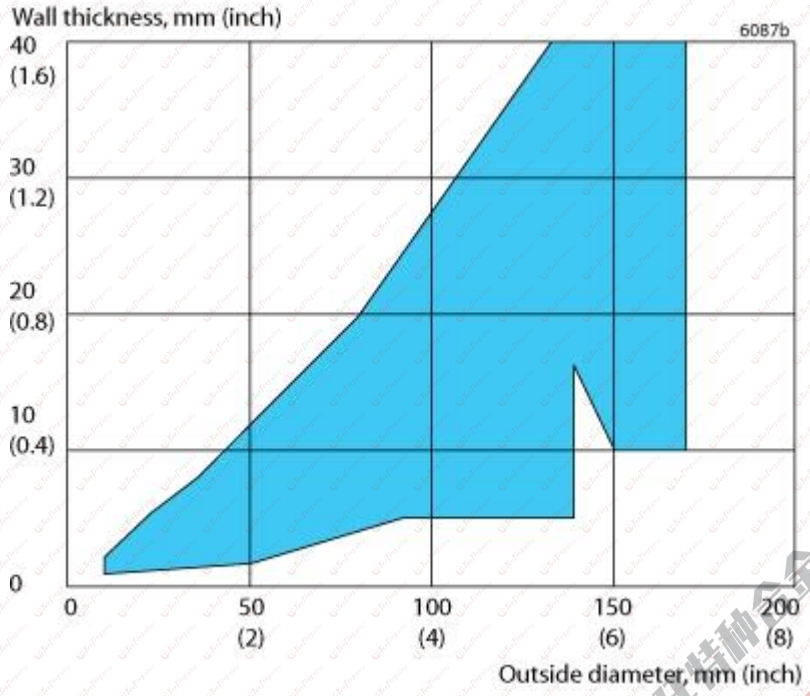

Figure 1. Principal size range for seamless tube and pipe.

Other forms of supply
Welding consumables

MECHANICAL PROPERTIES

At 20 °C (68 °F)

Metric units

Condition	Proof strength		Tensile strength	Elongation	Hardness Vickers
	$R_{p0.2}$ [a]	$R_{p1.0}$ [a]	R_m	A [b]	
	MPa	MPa	MPa	%	
					approx.
Cold finished OD≤127 mm	≥241	≥265	552-700	≥35	160
Cold finished OD>127 mm	≥205	≥265	552-700	≥35	160
Hot finished	≥205	≥230	550-700	≥35	160

Imperial units

Condition	Proof strength		Tensile strength	Elongation	Hardness Vickers
	$R_{p0.2}$ [a]	$R_{p1.0}$ [a]	R_m	A2"	
	ksi	ksi	ksi	%	
					approx.
Cold finished OD ≤ 5"	≥35	≥38	80-101	≥35	160
Cold finished OD > 5"	≥30	≥38	80-101	≥35	160
Hot finished	≥30	≥33	80-101	≥35	160

1 MPa = 1 N/mm2

a) Rp0.2 and Rp1.0 correspond to 0.2% and 1.0 % offset yield strength, respectively.
b) Based on L0 = 5.65 ÖS0 where L0 is the original gauge length and S0 the original cross-section area.

At high temperatures

Metric units

Temperature	Proof strength	Tensile strength
°C	Rp0.2	Rm
	MPa	MPa
	min.	min.
100	200	500
200	180	480
300	170	470
400	160	460
500	140	450
600	100	440

Imperial units

Temperature	Proof strength	Tensile strength
°F	Rp0.2	Rm
	ksi	ksi
	min.	min.
200	29.6	73.2
400	26.0	69.6
600	24.4	67.9
800	22.4	66.3
1000	18.1	64.7
1100	14.9	63.9

Creep strength

Sanicro® 70 has a creep strength which is comparable to that of AISI tp 310 (UNS S31008).

PHYSICAL PROPERTIES

Density: 8.4 g/cm3, 0.30 lb/in3

Scaling temperature in air: 1175 °C, 2145 °F

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	13	68	7.5
100	14	200	8
200	16	400	9
300	17	600	10
400	19	800	11
500	21	1000	13

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
600	25	1100	15

Specific heat capacity

Temperature, °C	J/kg °C	Temperature, °F	Btu/lb °F
20	460	68	0.11
100	480	200	0.11
200	495	400	0.12
300	510	600	0.12
400	515	800	0.12
500	525	1000	0.13
600	590	1100	0.14

Thermal expansion, **mean values in temperature ranges (x10^{-6})**

Temperature, C	Per °C	Temperature, °F	Per F
30-100	13.5	86-200	7.5
30-200	14	86-400	8
30-300	14	86-600	8
30-400	14.5	86-800	8
30-500	15	86-1000	8.5
30-600	15.5	86-1100	8.5

Modulus of elasticity **(x10^{3})**

Temperature, °C	MPa	Temperature, °F	ksi
20	214	68	31.0
100	206	200	30.0
200	202	400	29.3
300	196	600	28.3
400	190	800	27.4
500	185	1000	26.6
600	180	1200	25.5
700	171	1400	23.9
800	161	1600	22.1
900	149	1800	19.9
1000	135		

CORROSION RESISTANCE

General corrosion

Sanicro® 70 has approximately the same resistance to organic and inorganic acids as steel of the AISI 304 type. Its resistance to sodium hydroxide is very good even at high concentrations and temperatures.

Pitting

Resistance to pitting is equal to that of steel of the AISI 304 type.

Stress corrosion cracking

Sanicro® 70 has very good resistance to stress corrosion cracking, particularly in chloride-bearing solution.

Gas corrosion

Sanicro® 70 has very good oxidation resistance. It can be used in:

- Air up to 1175°C (2145°F)
- Up to 800°C (1470°F)
- Dry chlorine and hydrogen chloride up to about 550°C (1020°F)
- Synthesis gas (ammonia synthesis) up to 600°C (1110°F). The resistance to nitrogen absorption, e.g. cracked ammonia at high temperatures, is very good.

Due to high nickel content the material should not be used in reducing, sulphurous atmospheres (containing hydrogen sulphide) at temperatures above 550°C (1020°F).

HEAT TREATMENT

The tubes are delivered in heat treated condition. If another heat treatment is needed after further processing the following is recommended.

Stress relieving

800-875°C (1470-1920°F), 10-15 minutes, cooling air.

Solution annealing

950-1050°C (1740-1920°F), 5-30 minutes, rapid cooling in air or water.

WELDING

The weldability of Sanicro® 70 is good. Suitable fusion-welding methods are manual metal-arc welding (MMA) and gas-shielded arc welding, with the TIG and MIG methods as first choice. Preheating and post-weld heat treatment are normally not necessary.

The welding of high-nickel materials calls for high standards of cleanliness. Joint surfaces and filler metals must be free from grease, dirt, color (pigments) and other impurities. If necessary, the welding zone shall be cleaned with a suitable solvent, e.g. acetone or alcohol.

Since Sanicro® 70 has low thermal conductivity and high thermal expansion, welding must be carried out with a low heat input and with welding plans well thought out in advance, so that the deformation of the welded joints can be kept under control.

The welding of fully austenitic steels often entails the risk of hot-cracking in the weld metal, particularly if the weldment is under constraint. To reduce the cracking risk, the welding should be carried out with lowest practical heat input, <1.0 kJ/mm and interpass temperature <150°C.

Recommended filler metals for:
MIG and TIG: Sanicro® 72HP or Sanicro® 68HP (wire electrodes and filler wire/rods). MMA: Sanicro 71 or Sanicro® 69 (covered electrodes).

BENDING

Heat treatment after cold bending is not normally necessary, but this point must be decided with regard to the degree of bending and the operating conditions. Heat treatment, if any, should take the form of stress relieving or solution annealing.

Hot bending is carried out at 1100-850°C (2010-1560°F) and should be followed by solution annealing.

APPLICATIONS

Sanicro® 70 has good resistance to chlorine and hydrogen chloride at high temperatures and can therefore be used in the production of chlorinated hydrocarbons, e.g. in the oxychlorination reactor and the cracking furnace in vinylchloride plants.

Sanicro® 70 can also be used in wet corrosive conditions, where austenitic 18Cr/8Ni steels would be susceptible to stress corrosion cracking.

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