

Exera® SAF 2205™ SH medical wire

Wire

Datasheet

Exera® SAF 2205™ SH is a duplex (austenitic/ferritic) stainless steel with super high tensile strength.

The grade is characterized by:

- Very good corrosion resistance
- High resistance to stress corrosion cracking in chloride-bearing environments
- High resistance to stress corrosion cracking in environments containing hydrogen sulphide
- High resistance to general corrosion, pitting, and crevice corrosion
- High resistance to erosion corrosion and corrosion fatigue
- Extremely high tensile strength in 'as delivered' condition
- Very good relaxation resistance
- Physical properties that offer design advantages

Service temperature: -100 to 300°C (-150 to 570°F)

Service temperature: -200 to 280°C (-330 to 540°F)

Standards

- UNS: S32205/S31803
- EN Number: 1.4462
- EN Name: X2CrNiMoN22-5-3
- W.Nr.: 1.4462

Applications

Exera® SAF 2205™ SH can be used for dental instruments.

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.030	≤0.5	≤0.9	≤0.030	≤0.015	22	5.0	3.2	0.18

Forms of supply

Surface conditions and dimensions

Surface finish	Dimension, mm	in.
Coated	0.4 – 3.0 ^{*)}	0.016-0.118 ^{*)}
Bright	0.20 – 0.80	0.008-0.031
Polished	0.4 - 1.0	0.016-0.039
Degreased	0.4-3.0 ^{*)}	0.016-0.118 ^{*)}

*) Dimensions >1 mm on request only

Delivery forms

Wire is delivered in lots and forms according to customers' requirements:

- On various types of spool with wire weights up to 500 kg (1100 lb)
- In straightened lengths 0.45 to 4 m (1.5 to 13 ft)

Mechanical properties

At 20°C (68°F)

Tensile strength, R_m, and proof strength, R_{p0.2}, MPa (ksi) in the 'as delivered' condition

Wire diameter	Nominal, R _m	Nominal R _{p0.2}			
	in.	+/- 100 MPa	+/- 15 ksi	MPa	ksi
0.20 – 0.70	0.0079 - 0.028	2550	370	2050	297
>0.70 - 0.80	>0.028 - 0.031	2400	348	2000	290
>0.80 - 1.00	>0.031 - 0.039	2300	334	1950	283
>1.00 - 1.50	>0.039 - 0.059	2250	326	1915	278
>1.50 - 2.00	>0.059 - 0.079	2150	312	1800	261
>2.00 - 2.50	>0.079 - 0.098	2050	297	1745	253
>2.50 - 3.00	>0.098 - 0.118	2000	290	1700	247

1) R_{p0.2} corresponds to 0.2% offset yield strength.

2) Dimensions >1 mm on request only

Tensile strength can be increased by 200 MPa (29 ksi) up to 450 MPa (65 ksi) by tempering depending on tensile and tempering conditions. Please see heat treatment for further information. The tensile strength variation between spools/coils within the same production lot is ±50 MPa (7 ksi) maximum. Yield strength in the tempered condition is approx. 90 % of the tempered tensile strength. Tensile strength values are guaranteed and are measured directly after production. During storage, both the tensile strength and yield strength will

increase somewhat due to ageing. Depending on the storage conditions, the tensile strength can increase by 0 - 80 MPa (0 - 12 ksi).

The tensile strength and yield strength will decrease by 3–4% per 100°C (210°F) increase in service temperature.

Straightened lengths

Straightening will reduce the tensile strength by approx. 7 %.

Fatigue strength

The diagrams below are based on tempered and pre-stressed cylindrical helical springs with a wire surface free from tooling damage.

At elevated temperatures, the fatigue strength decreases at

100°C (210°F): by about 5 %

200°C (390°F): by about 10 %

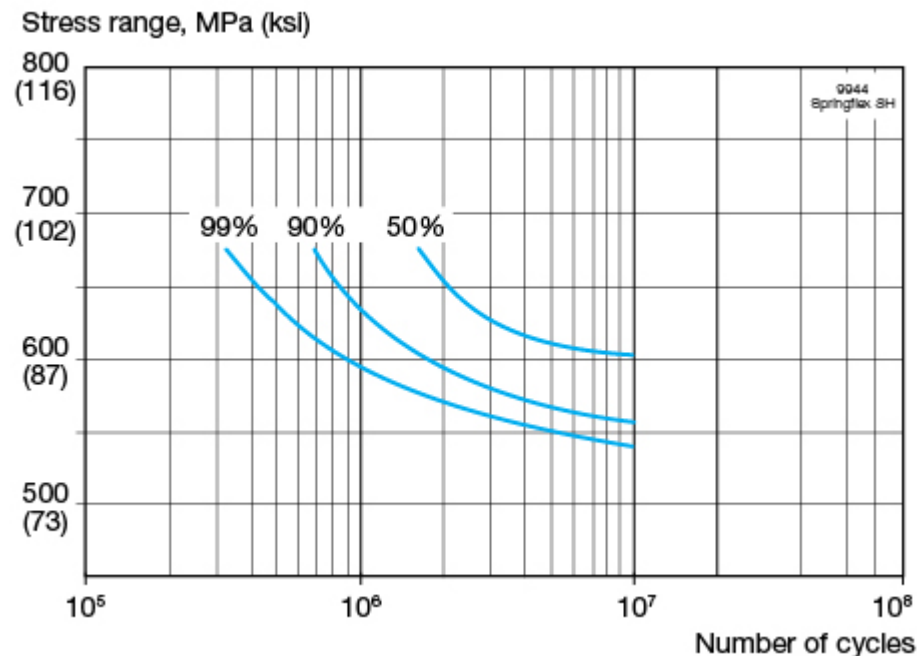


Figure 1. Wöhler diagram, mean stress 450 MPa (65 ksi). The curves are valid for springs coiled from wire 1.00 mm (0.039 in.) in diameter and represents 50%, 90% and 99% certainty against failure. Stress range = double the stress amplitude

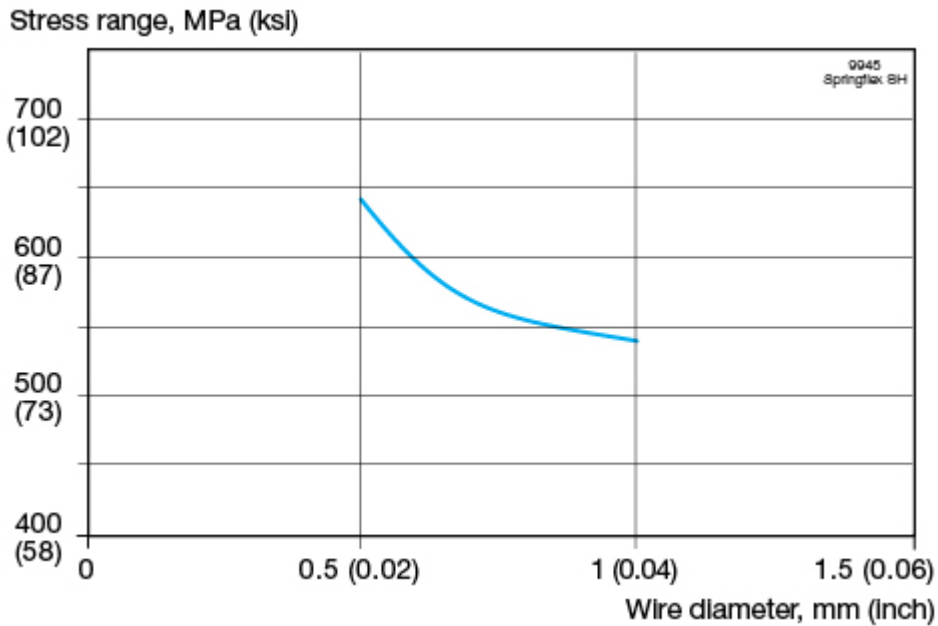


Figure 2. Stress range for different wire diameters, mean stress 450 MPa (65 ksi). Stress range at 10^7 load cycles as a function of the wire diameter and 90% certainty against failure.

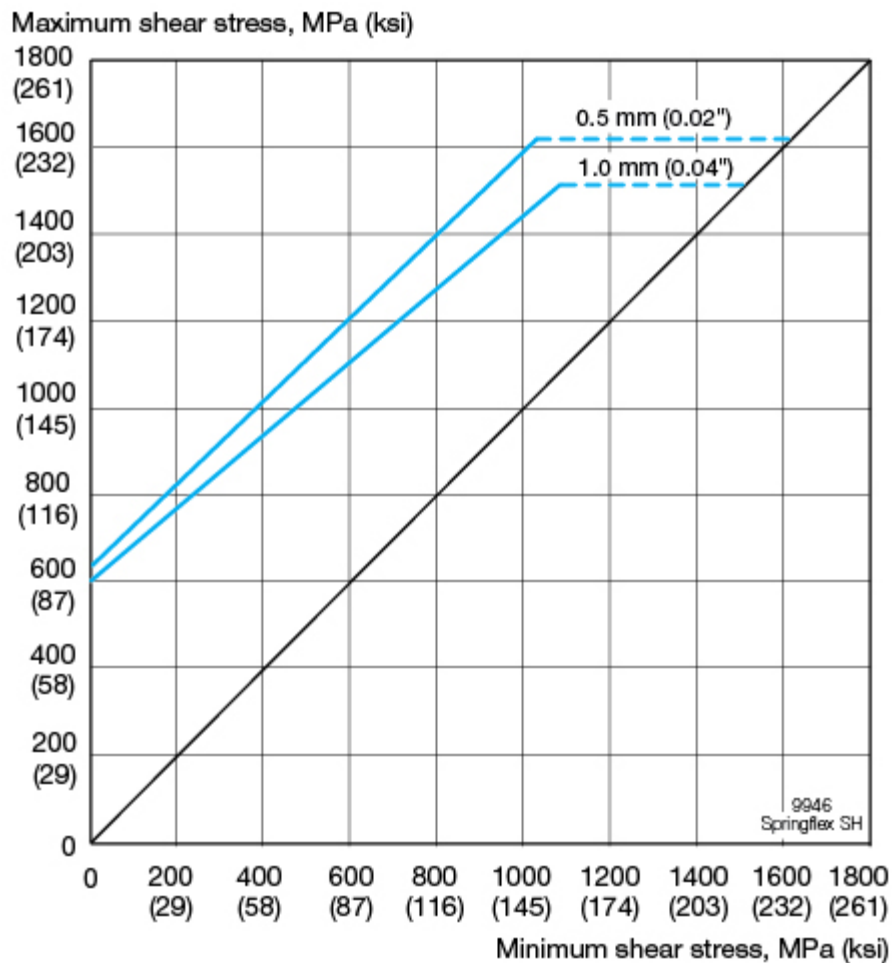


Figure 3. Modified Goodman diagram for different wire diameters. The curves are valid for 10^7 load cycles and represent 90 % certainty against failure.

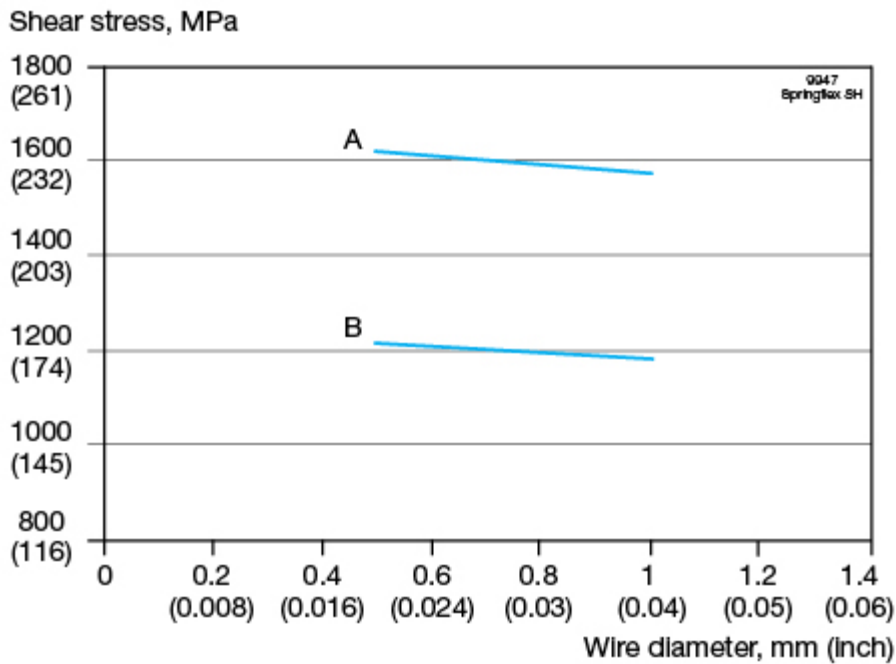


Figure 4. Setting limit and maximum permissible shear stress. Setting limit curve A, and maximum permissible shear stress, curve B, as a function of the wire diameter. The setting limit is defined as the shear stress at which the relaxation is 2% after a load time of 24 hours. Curve B lies 25% below curve A.

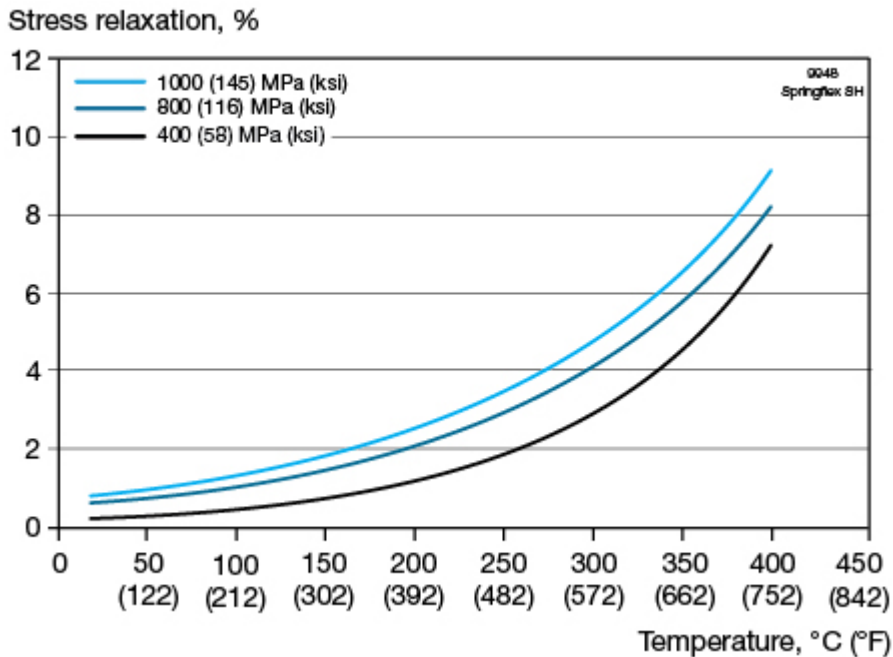


Figure 5. Relaxation 24 hours. Relaxation (load loss) at various shear stresses as a function of service temperature. This diagram refers to a wire diameter of 1.0 mm (0.039 in.).

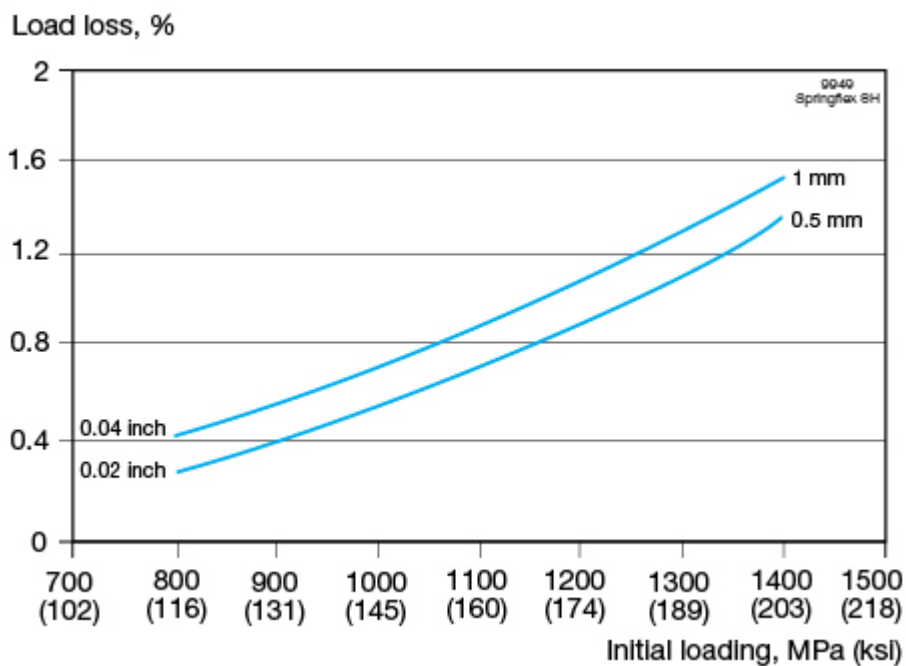


Fig 6. Relaxation, 24 hours. Relaxation (load loss) at various shear stresses as a function of wire diameter.

Physical properties

Density: 7.8 g/cm³, 0.28 lb/in³

Specific heat capacity

500 J/kg °C in the temperature range 50 - 100°C

0.12 Btu/lb °F in the temperature range 120 - 212°F

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	14	68	9
100	16	212	9
200	17	390	10
300	19	570	11

Resistivity

Temperature, °C	μΩm	Temperature, °F	μΩin.
20 - 100	0.84	120 - 212	33

Thermal expansion

Mean values in temperature ranges (x10⁻⁶)

Cold worked

Metric units

Temperature, °C per °C	30-100	30-200	30-300	30-400
	12.5	11.5	11.5	12.0

Imperial units

Temperature, °F per °F	86-200	86-400	86-600	86-800
	7.0	6.5	6.5	6.5

Aged

Metric units

Temperature, °C per °C	30-100	30-200	30-300	30-400
	13.0	13.5	13.5	14.0

Imperial units

Temperature, °F per °F	86-200	86-400	86-600	86-800
	7.0	7.5	7.5	8.0

Magnetic permeability, μ_{\max}

Annealed	60
Cold drawn	120

Shear modulus, MPa (ksi)

as delivered: approx 77 000 (11 165)
tempered: approx 80 000 (11 600)

Modulus of elasticity, MPa (ksi)

as delivered: approx 200 000 (29 000)
tempered: approx 208 000 (30 160)

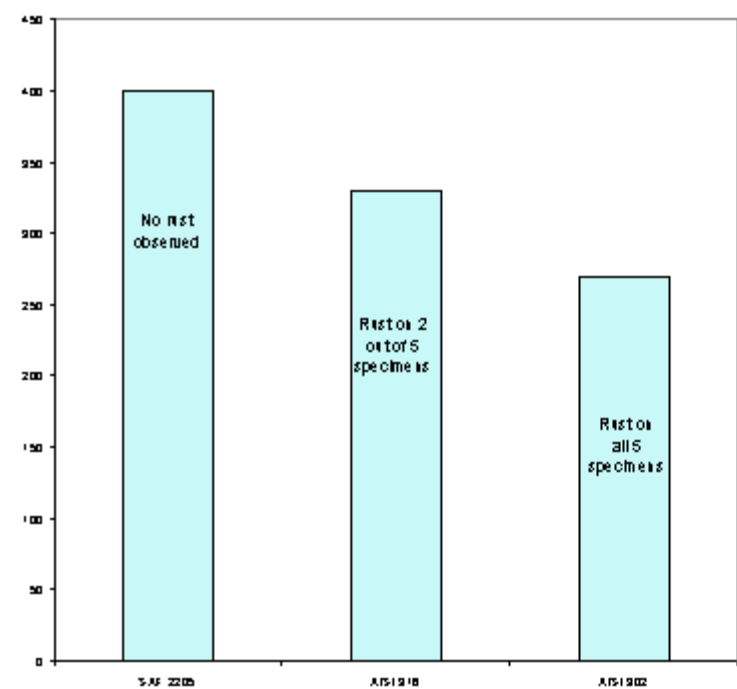
Corrosion resistance

Chloride induced corrosion

In seawater and other high chloride content environments, Exera® SAF 2205™ SH has better corrosion resistance than stainless steel of type ASTM 316 because of its high PRE number (Pitting Resistance Equivalent, a parameter for comparing the resistance of different steels to pitting). The PRE number is defined as, in weight-%: $PRE = \% Cr + 3.3 \times \% Mo + 16 \times \% N$. The better resistance of Exera® SAF 2205™ SH can be demonstrated by e.g. salt spray testing, where samples are sprayed with water containing 5 % NaCl at 35°C (95°F) and checked every 24 hours. See the diagram below.

Neutral salt spray test according to ASTM B 117

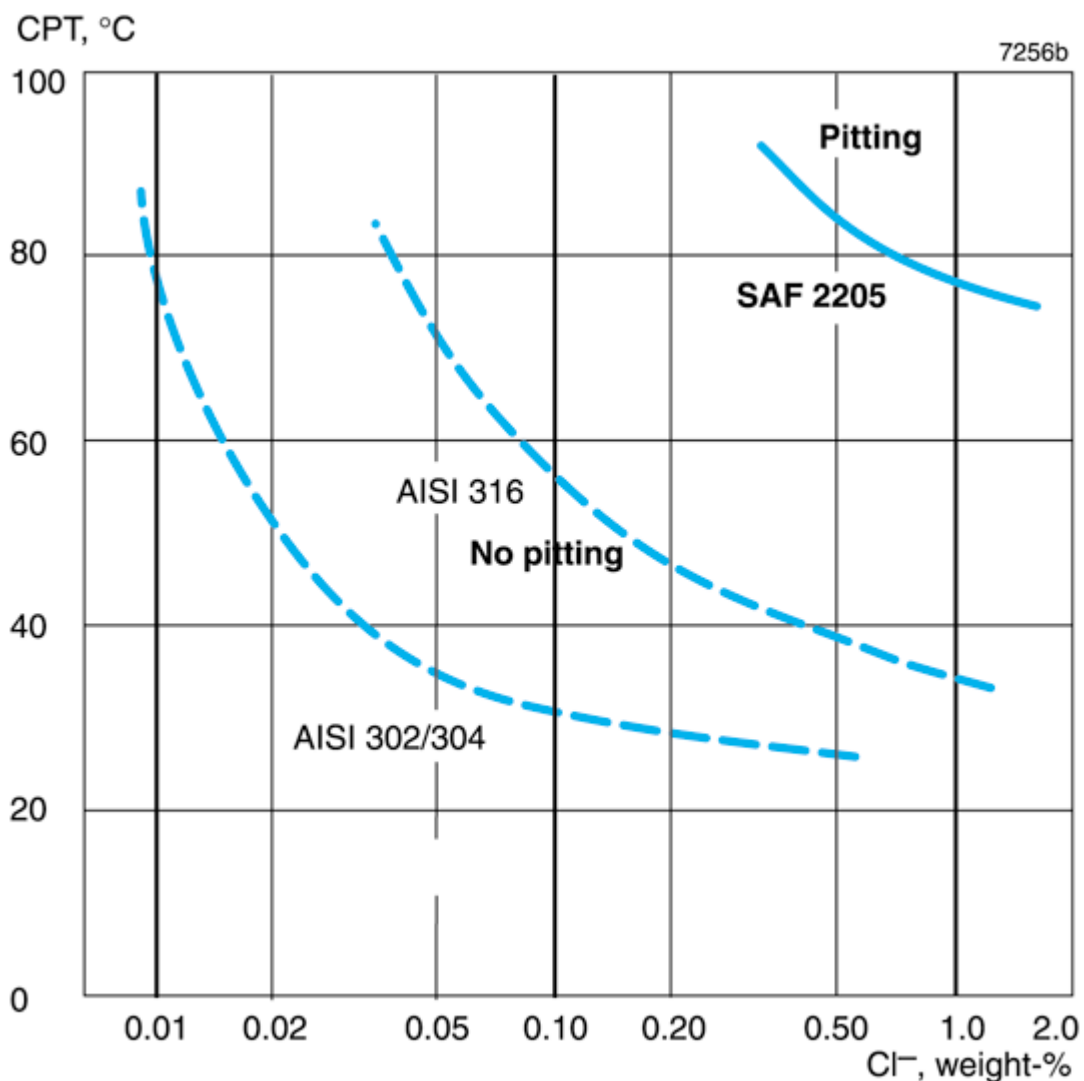
Testing time, hours



Critical

pitting temperature

In high saline content environments such as salt water, the aggressiveness of the environment increases as the temperature rises. All stainless steels have a critical pitting temperature above which there is a risk of pitting. The critical pitting temperature for Exera® SAF 2205™ SH and ASTM 316, as a function of chloride concentrations, is shown in the diagram.



Crevice corrosion

Crevice corrosion is, in principle, the same as pitting corrosion, but occurs in crevices and cracks, e.g. between flange joints, under deposits on the metal surface or in welds with incomplete penetration. Crevice corrosion often occurs at lower temperatures and at lower chloride contents than those necessary for pitting to occur. Resistance is influenced by the content of Cr, Mo and N in the same way as pitting resistance.

Stress corrosion cracking

Stress corrosion cracking leading to catastrophic failure might occur with standard austenitic steels. Exera® SAF 2205™ SH, thanks to its duplex structure, is significantly more resistant to this type of corrosion.

Bending

The minimum bending radius should not be less than half the wire diameter. The wire surface should be free from any tooling damage because slight imperfections in the surface can lead to fracture, even at large bending radii.

Heat treatment

Spring tempering will increase the tensile strength by 200 MPa (29 ksi) up to to 450 MPa (65 ksi) depending on tensile and tempering conditions.

We recommend 450°C (840°F) / 1–3 h for batch tempering. To obtain best results, when tempering in a continuous conveyor furnace, where holding time at full temperature is very short, the temperature should be

increased preferably to about 500°C (930°F). The holding time should be 3 - 10 minutes. Shorter times may result in uneven tempering.

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