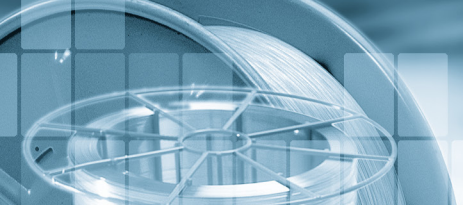

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Sandvik Springflex ESP

(Wire)

Sandvik Springflex is a duplex (austenitic-ferritic) stainless steel recommended for service in dynamic electrostatic precipitator environments, The grade is characterized by:

- Very good fatigue resistance
- High resistance to stress corrosion cracking (SCC) in chloride-bearing environments
- High resistance to stress corrosion cracking (SCC) in environments containing hydrogen sulphide
- High resistance to general corrosion, pitting, and crevice corrosion
- High resistance to erosion corrosion and corrosion fatigue
- Physical properties that offer design advantages

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

STANDARDS

- UNS S32205/S31803
- EN number 1.4462
- EN name X2CrNiMoN 22-5-3

CHEMICAL COMPOSITION (NOMINAL) %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤0.030	0.5	0.9	≤0.030	≤0.015	22	5	3.2	0.18

FORMS OF SUPPLY

Sandvik Springflex ESP for dynamic electrostatic precipitators (ESP) is supplied bright drawn and degreased, in continuous lengths, without welds, on metallic spools.

Dimensions
Standard dimension for the product is 2.70 mm.
Other dimensions can be manufactured on request.

Tolerances
Standard diameter tolerance: +/- 0.020 mm.
Roundness tolerance: max 0.020 mm.

Surface purity
Wire is supplied with a cleaned surface with a maximum chloride ion content of 0.2 mg/dm^2.

MECHANICAL PROPERTIES

1

Sandvik Springflex ESP for dynamic electrostatic precipitators (ESP) is tested and certified in accordance with a minimum nominal tensile strength. The proof strength is approximately 85% of the tensile strength.

At 20°C (68°F)

Proof strength, $R_{p0.2}$	Tensile strength, R_m
MPa	MPa
approx. 890	≥1050

PHYSICAL PROPERTIES

Density: 7.8 g/cm^3, 0.28 lb/in^3

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

Magnetic permeability, μ_{max}	
Annealed	60
Cold drawn	120

Shear modulus, MPa (ksi)
As delivered: approx 77 000 (11 200)
Tempered: approx 79 000 (11 500)

Modulus of elasticity, MPa (ksi)
As delivered: approx 200 000 (29 000)
Tempered: approx 205 000 (29 700)

CORROSION RESISTANCE

General corrosion
The most common environments, where general corrosion occurs in stainless steels, are strongly acidic or alkaline solutions. The specific composition of the environment is crucial for corrosiveness, and may change drastically if oxidizing or reducing compounds are added. The performance of stainless steel grades can vary considerably in the same environment and to different additives. It is, therefore, extremely important that the environment, where a product is to be used, is characterized thoroughly. When this is done, a suitable material can usually be selected. The economic advantages of choosing a grade with high corrosion resistance, sometimes acquired at a higher price per kilo, can be illustrated by estimating life cycle cost. In most media, Sandvik Springflex ESP possesses better resistance to general corrosion than steel of type ASTM 316L.

Pitting
The pitting resistance of a steel is determined primarily by its chromium and molybdenum contents, but also by its nitrogen content, as well as its slag composition and slag content. A parameter for comparing the resistance of different steels to pitting is the PRE number (pitting resistance equivalent).

The PRE is defined as, in weight-%:
PRE = % Cr + 3.3 x % Mo + 16 x % N
The PRE numbers for Sandvik Springflex ESP and two standard materials are given in the following table.

Grade	% Cr	% Mo	% N	PRE
Sandvik Springflex ESP	22	3.2	0.18	>35
ASTM 316L	17	2.2	-	24
ASTM 302/304	18	-	-	18

The ranking given by the PRE number has been confirmed in laboratory tests. This ranking can generally be used to predict the performance of an alloy in chloride containing environments.

Laboratory determinations of critical temperatures for the initiation of pitting (CPT) at different chloride contents are shown in the figure below. The chosen testing conditions have yielded results that agree closely with practical experience.

Sandvik Springflex ESP can be used at considerably higher temperatures and chloride contents than ASTM 302/304 and ASTM 316 without pitting. It is, therefore, far more serviceable in chloride-bearing environments than standard austenitic steels.

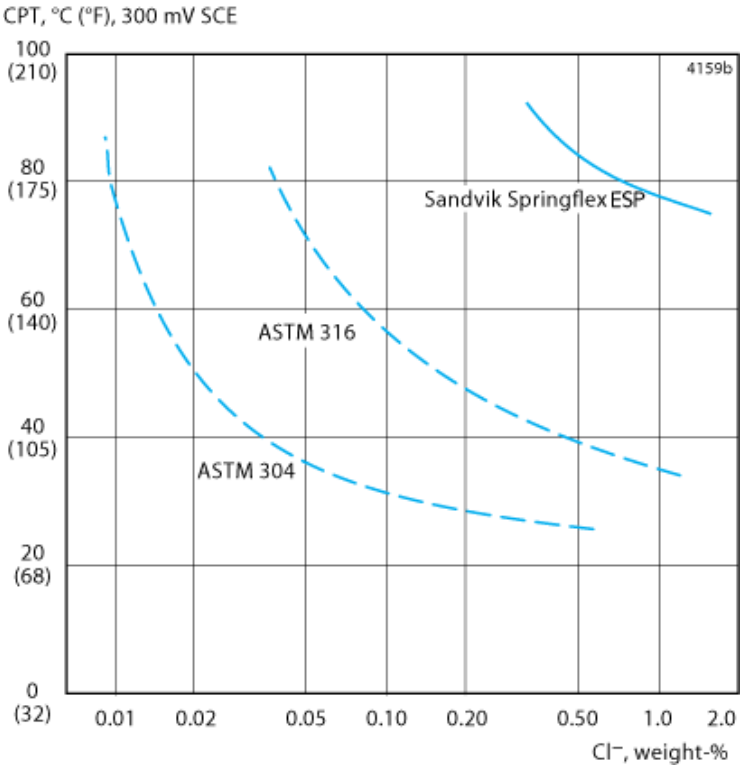

Figure 6. CPT at varying concentrations of sodium chloride (potentiostatic determination at +300mV SCE), pH appr 6.0.

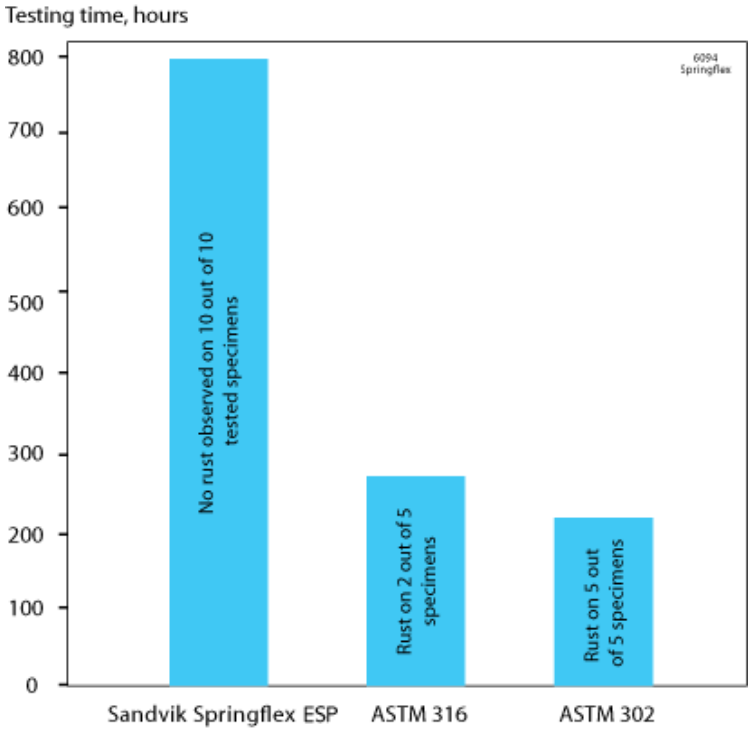

Figure 7. Neutral salt spray test according to ASTM B 117. Springs in the tempered and unpassivated condition were sprayed with neutral, 5 % by volume, salt solution at 35°C (95°F), pH 6.5 - 7.2. Inspections were carried out every 24 hours.

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
The standard austenitic steels of the ASTM 302/304 and ASTM 316L types are prone to stress corrosion cracking (SCC) in chloride-bearing solutions at temperatures above 60°C (140°F).

Duplex stainless steels are far less prone to this type of corrosion. Laboratory tests have shown the good resistance to stress corrosion cracking of Sandvik Springflex ESP. Results from these tests are presented in the diagrams below. The first diagram indicates the temperature-chloride range within which Sandvik Springflex SH and the standard steels ASTM 302/304 and ASTM 316L can be used without risk of stress corrosion cracking.

Results of laboratory tests carried out in calcium chloride are shown in the next diagram. The tests have been continued to failure or a max. test time of 500 h. The diagram shows that Sandvik Springflex ESP has a much higher resistance to SCC than the standard austenitic steels ASTM 302/304L and ASTM 316L. In aqueous solutions containing hydrogen sulphide and chlorides, stress corrosion cracking can also occur in stainless steels at temperatures below 60°C (140°F). The corrosivity of such solutions is affected by acidity and chloride content.

Laboratory tests of Sandvik Springflex ESP have confirmed the good resistance to stress corrosion cracking in environments containing hydrogen sulphide. This has also been verified by available operating experience.

In accordance with NACE MR0175/ISO 15156 solution annealed and cold-worked UNS S31803 (Sandvik Springflex ESP) is acceptable for use at any temperature up to 450°F (232°C) in sour environments, if the partial pressure of hydrogen sulphide does not exceed 0.3 psi (0.02 bar) and its hardness is not greater than HRC 36.

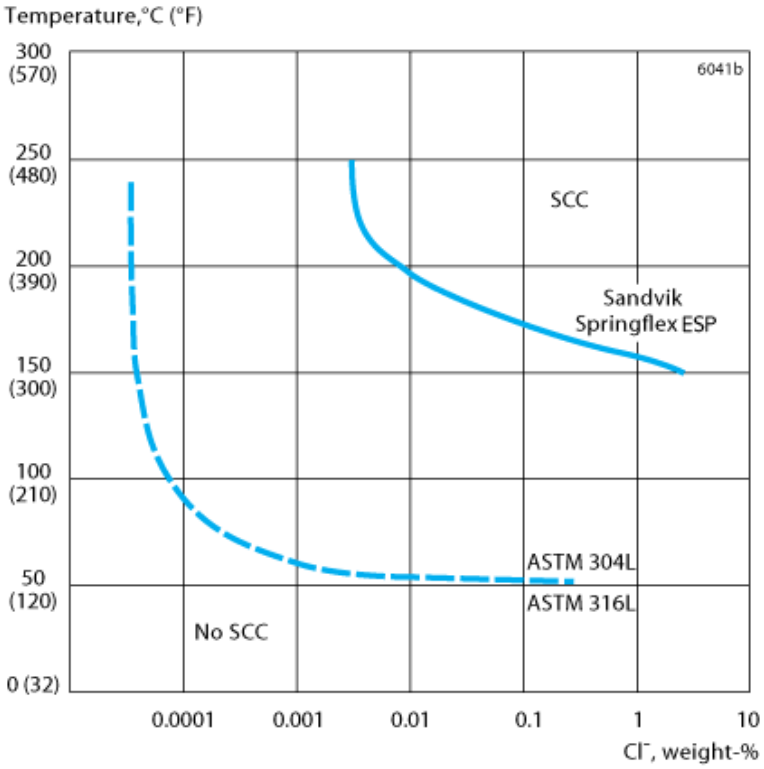

Figure 8. Resistance to stress corrosion cracking, laboratory results for annealed UNS S31803 (Sandvik Springflex ESP) of constant load specimens loaded to 85% of the proof strength at the test temperature.

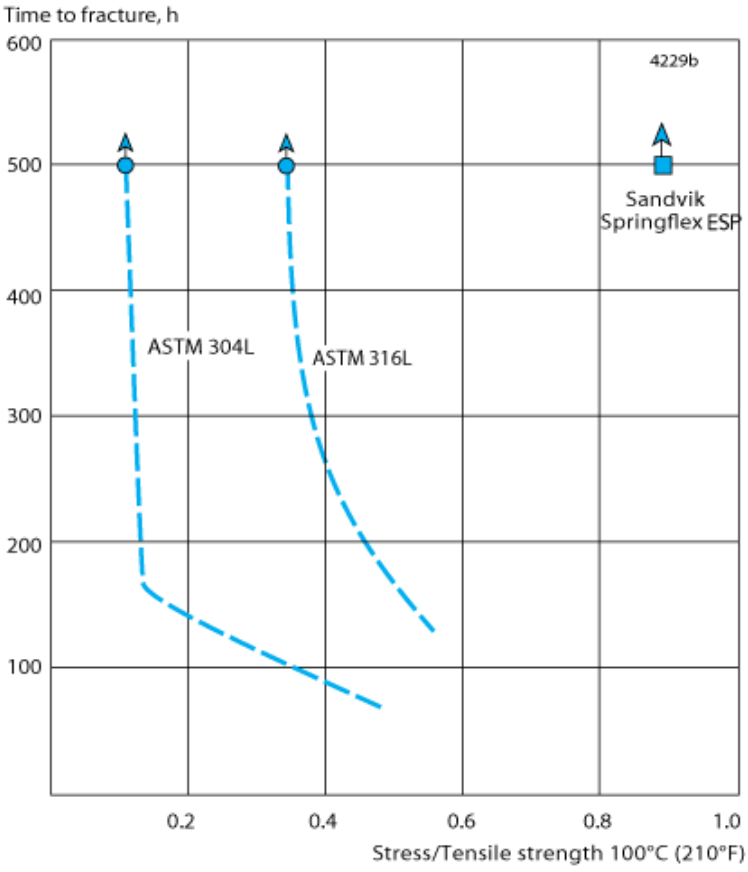

Figure 9. Results of stress corrosion cracking tests on annealed UNS S31803 (Sandvik Springflex ESP), ASTM 302/304L and ASTM 316L in 40 % $CaCl_2$ at 100°C (210°F) with an aerated test solution.

Figure 10. Constant-load SCC tests in acidified aqueous solution. Stress = 0.2 proof strength at testing temperature = 90°C (194°F). Testing time 500 hours. Sanicro 28 and Sandvik Springflex ESP tested in the cold-worked condition, ASTM 420 quenched and

tempered.

BENDING

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