OTEVA 91 SC

Oil tempered SiCrVMo-alloyed ultra-high tensile valve spring wire for surface nitriding

OTEVA® 91 SC is a Super Clean steel, especially intended for the manufacture of clutch/transmission springs with extremely high fatigue properties and good relaxation properties at increased working temperatures. Manufactured as standard in shaved condition in sizes from Ø 2.00 mm to 10.0 mm, or in egg or elliptical shape corresponding to round cross section 2.50 mm to 6.00 mm. Other wire sizes on request.

OTEVA® 91 SC PLUS is intended for manufacture of valve springs and other springs requiring extremely high fatigue properties and good relaxation properties at increased working temperatures.

Further information about the approval process for OTEVA SC PLUS is found here.

CHEMICAL COMPOSITION

C (%)	Si (%)	Mn (%)	P max. (%)	S max. (%)	Cr (%)	V (%)	Mo (%)
0.50 - 0.70	1.80 - 2.20	0.30 - 0.60	0.020	0.025	0.80 - 1.00	0.05 - 0.15	0.05 - 0.15

CLEANLINESS IN STEEL

The presence of non-metallic inclusions in the wire rod is inspected for every heat of OTEVA® 91 SC in accordance with the Suzuki Garphyttan method by the steel supplier.

Before release for production, Suzuki Garphyttan performs non-metallic inclusion inspection for every fifth heat. The criteria for supplier inspection and releasing inspection are the following;

For wire rod samples: Inclusion size max. 15 µm down to 1 mm below surface. Inspection area: 1 000 mm^2.

Inclusion size, surface	5-10 µm	>10-15 µm	>15 µm
Max. number of inclusions	50	7	0

For OTEVA 91 SC PLUS, every heat is inspected including a SEM-EDS analysis of inclusions > 10µm to verify a Super Clean composition.

As stated by IVSWMA, International Valve Spring Wire Manufacturers Association, it is likely to find occasional inclusions in valve spring quality steel of a size larger than 30 µm.

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MECHANICAL PROPERTIES

1) Other wire sizes on request.
2) Ovality, i. e. the difference between the largest and smallest dimension of a cross section, is maximum half the tolerance range.
3) Conversion from tensile strength to hardness values can be calculated in standard ISO EN 18265. The tensile strength Rm within one coil does not vary more than 50 N/mm^2.
4) Torsion test is carried out at ≤ 6.0 mm for assessing deformability. The fracture of the torsion test piece shall be smooth and perpendicular to the wire axis. The rupture shall show no longitudinal cracks.

FOR ROUND WIRE

Diameter (mm)	Tolerance (mm)	Tensile Strength (N/mm^2)	Torsions (l=300 mm, min. revs)	Reduct. of area (min. %)
2.00 - 2.50	±0.020	2180 - 2280	5	45
2.51 - 3.20	±0.020	2130 - 2230	5	45
3.21 - 4.00	±0.025	2080 - 2180	4	45
4.01 - 5.00	±0.025	2030 - 2130	3	45
5.01 - 5.60	±0.030	1980 - 2080	3	40
5.61 - 6.00	±0.035	1980 - 2080	3	40
6.01 - 7.00	±0.040	1910 - 2010		35
7.01 - 8.00	±0.045	1860 - 1960		35
8.01 - 9.00	±0.045	1860 - 1960		35
9.01 - 10.00	±0.050	1860 - 1960		35

YIELD POINT

The proof stress $R_{p0.2}$ is min. 0.8 x tensile strength of the wire. The proof stress will rise above 0.9 x tensile strength after stress relieving the springs.

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SURFACE CONDITIONS

SURFACE CONDITION

Surface condition – non-destructive testing
In the standard size range 2.00 - 6.00 mm the wire is tested continuously in Eddy Current equipment to a surface level of ≥ 40 microns. For size range 6.01-8.60 mm is tested continuously in Eddy Current equipment to a surface level of ≥ 60 microns. Other wire sizes on request.

Surface condition – end sample test
The wire is end sample tested by means of etch testing and binocular inspection as well as microscopical inspection of the material structure.
Max. permissible depth of partial surface decarburiza-tion and surface defects, 1 % x wire diameter. In shaved condition; for diameters <=2 .00 mm 10 µm, for diameters > 2.00 mm 0.5% x d. For diameters > 6.60-10.00 mm 0.7% x d.

PHYSICAL PROPERTIES

E AND G MODULUS OF ELASTICITY

206 kN/mm^2

E AND G MODULUS OF SHEAR

79.5 kN/mm^2

STANDARDS

NEAREST EQUIVALENT STANDARDS

ASTM A877 D

RECOMMENDATIONS

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HEAT TREATMENT

As soon as possible after coiling, the springs should be stress relieved. Depending on nitriding temperature used later in the valve spring manufacturing process, this temperature may be decreased.

HOT PRESETTING

After shot peening, the springs should be hot preset or stress relieved. In order to reach optimum fatigue and relaxation properties, the springs must be preset at an appropriate stress.

SOFT SHOT PEENING

Before the nitriding process a soft shot peening process shall be applied in order to remove the oxide layer on the spring wire surface.

NITRIDING

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Springs of OTEVA® 91 SC should be nitrided to obtain optimum fatigue and relaxation properties. Our recommendation is gas nitriding.

SHOT PEENING

In order to obtain optimum fatigue properties, the process time should be adjusted to get a complete treatment. Size of shots should be adapted to wire dimension, pitch and shot peening equipment.

For nitrided springs with an extremely hard surface zone, it is important to use a shot peening media with high hardness. Shot peening of the inside of the spring coils is particularly critical.

SPRING CONDITIONS FOR TESTS

Spring conditions for fatigue and relaxation tests (specially designed test spring) Diagram 1 and 2:	
Wire size	Ø 3.85 mm
Diameter external	26.95 mm
Spring length, l0	53.0 mm
N active	4.15
Spring index	6.0
Stress relieving	
Temperature	450 ±5 °C (840 ±10 °F) min. 420 °C (790 ±10 °F) for nitriding
Time	30 minutes
Soft shot peened	
Speed	20-30 m/s
Time	5 min
Shot size	0.8 mm
Nitriding	Gas nitriding
Temperature	450-470°C
Time	5-20 hours
Aim for surface hardness	Min. 800 Hv
Aim for core hardness	Min. 560 Hv
Compound (white) layer	Max. 1 µm.

For further technical support, please contact Suzuki Garphyttan or visit www.suzuki-garphyttan.com for more information

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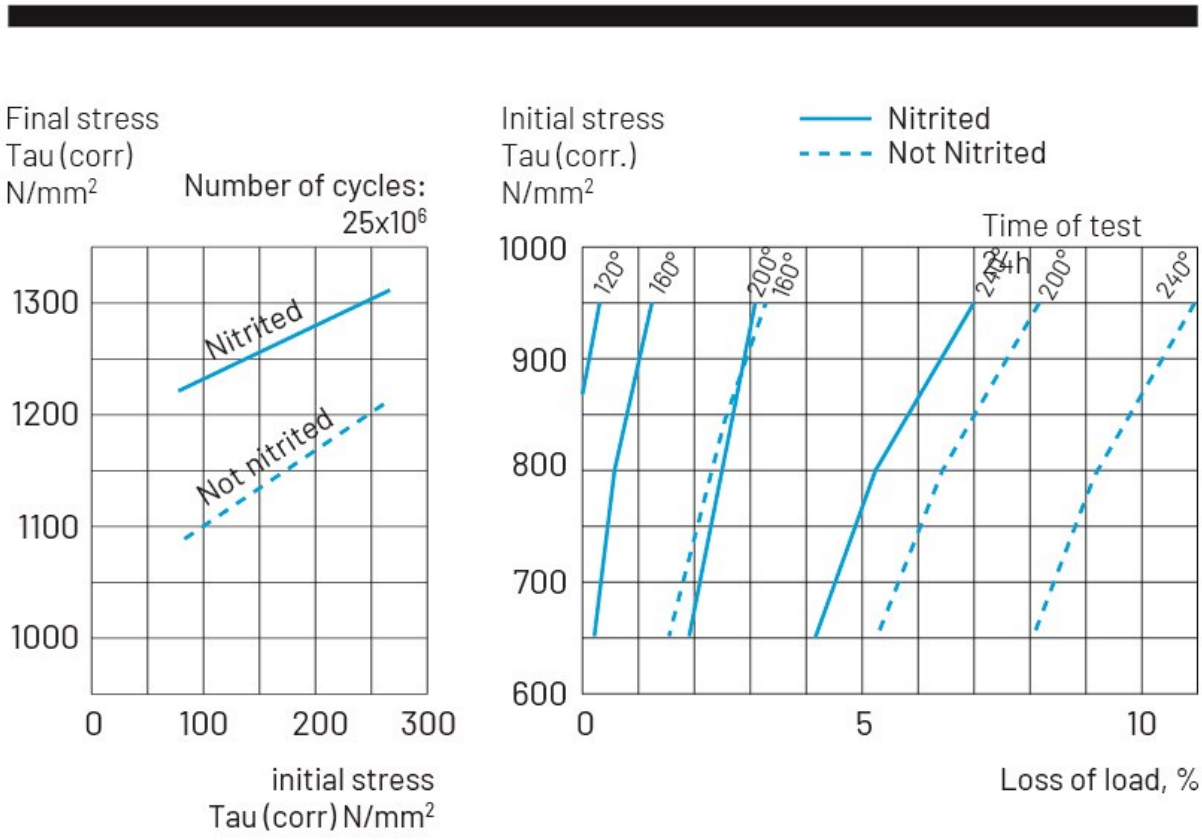
Shot peening (triple shot peening for nitrided springs)	
1st treatment	Pressure 0.3 MPa (~60m/s)* with RCW shot size 0.6 mm (hardness 800 Hv) for 20 minutes.
2nd treatment 3rd treatment Aim for Almen arc-height	Pressure 0.3 MPa (~60m/s)* with RCW shot size 0.25 mm (hardness 800 Hv) for 10 minutes. Pressure 0.2 MPa (~40m/s)* with fine shot size (hardness 700 Hv) for 10 minutes. 0.55 – 0.60 mm
Hot presetting (theoretically set)	1500 N/mm^2 (nitrided springs) 1300 N/mm^2 (not nitrided springs)
Temperature	200°C (max. 250°C)
Time	10 minutes

* Pressure setting for an air blast system and the approximate corresponding shot speed for a centrifugal blast wheel (in brackets).

RELAXATION AND FATIGUE PROPERTIES



In diagram 1 the fatigue properties of this grade are illustrated in a Goodman-diagram, based on a special test spring design.

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Diagram 2 shows the relaxation properties (loss of load) of springs made from OTEVA® 91 SC wire subjected to static compression at different temperatures, nitrided/not nitrided.