

OTEVA 90 SC Plus

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

OTEVA® 90 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.

Chemical composition

| Element | Weight % |
|---------|---------------|
| C | 0.50% - 0.70% |
| Si | 1.80% - 2.20% |
| Mn | 0.70% - 1.00% |
| P max. | 0.020% |
| S max. | 0.020% |
| Cr | 0.85% - 1.05% |
| V | 0.05% - 0.15% |
| Ni | 0.20% - 0.40% |

Cleanliness in steel

The presence of non-metallic inclusions in the wire rod is inspected for every heat of OTEVA® 90 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 mm².

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

For OTEVA 90 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.

Mechanical properties

Table definitions

Diameter: Other wire sizes on request.

Tolerance: Ovality, i. e. the difference between the largest and smallest dimension of a cross section, is maximum half the tolerance range.

Tensile strength: Conversion from tensile strength to hardness values can be calculated in standard ISO EN 18265. The tensile strength R_m within one coil does not vary more than 50 N/mm^2 .

Torsions: Torsion test is carried out 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. %) | Tensile strength after heat treatment 480C 1h (N/mm^2) |
|---------------|----------------|-------------------------------|--------------------------------|--------------------------|--|
| 2.00 - 2.50 | ± 0.020 | 2180 - 2280 | 5 | 45 | |
| 2.51 - 3.20 | ± 0.020 | 2130 - 2230 | 5 | 45 | 5 |
| 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 | |

| Diameter (mm) | Tolerance (mm) | Tensile Strength (N/mm ²) | Torsions (l=300 mm, min. revs) | Reduct. of area (min. %) | Tensile strength after heat treatment 480C 1h (N/mm ²) |
|---------------|----------------|---------------------------------------|--------------------------------|--------------------------|--|
| 5.61 - 6.00 | ±0.035 | 1980 - 2080 | 3 | 40 | |

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.

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. 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 decarburization and surface defects, 1 % x wire diameter. In shaved condition; for diameters ≤ 2.00 mm 10 μ m, for diameters > 2.00 mm 0.5% x d.

Technical specification

| Property | Value |
|-------------------------|-------------------------|
| E modulus of elasticity | 206 kN/mm ² |
| G modulus of shear | 79.5 kN/mm ² |

Steel grades and product standards

| | |
|--------------------------------------|-------------|
| Nearest equivalent product standards | ASTM A877 C |
|--------------------------------------|-------------|

Recommendations

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. See recommended procedure in the table below.

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

Springs of OTEVA® 90 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

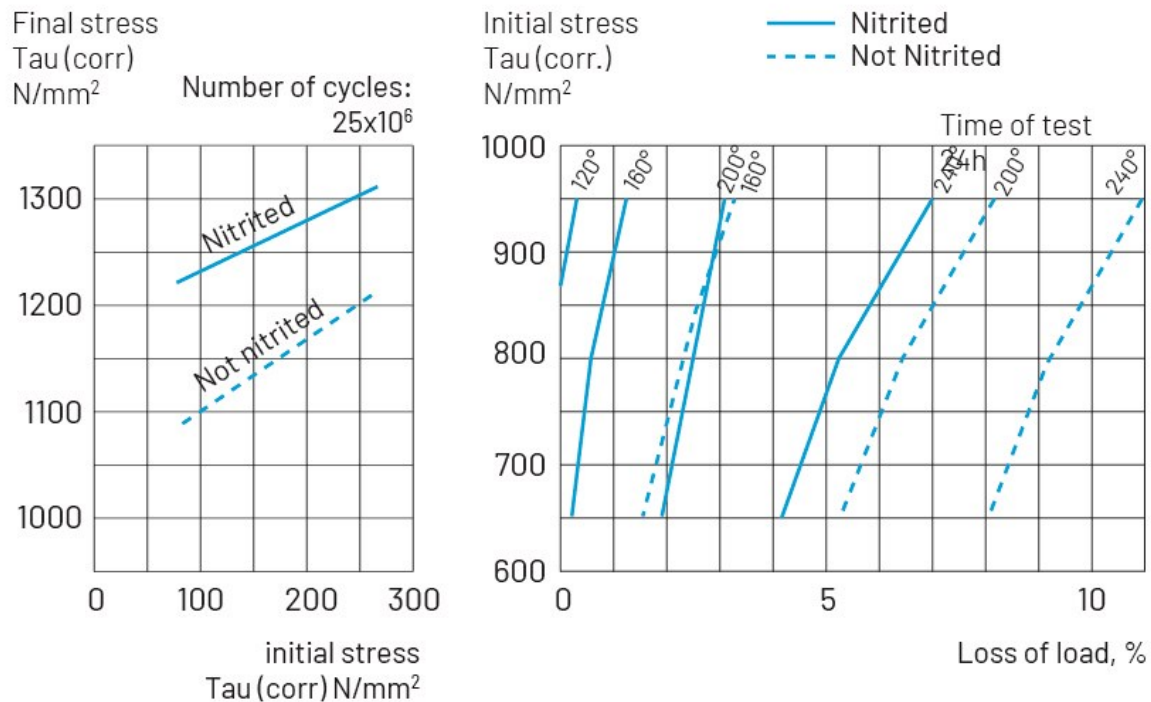
Spring conditions for fatigue and relaxation tests (specially designed test spring) Diagram 1 and 2:

| | |
|-------------------------------|---|
| Wire size | Ø 3.85 mm |
| Diameter external | 26.95 mm |
| Spring length, l ₀ | 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 | |
| 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 . |
| 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) f or 20 minutes. |
| 2nd treatment 3rd treatment | Pressure 0.3 MPa (~60m/s)* with RCW shot size 0.25 mm (hardness 800 Hv) f or 10 minutes. Pressure 0.2 MPa (~40m/s)* with fine shot size (hardness 700 Hv) for 10 minutes. 0.55 – 0.60 mm |
| Aim for Almen arc-height | |
| 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.

Diagram 2 shows the relaxation properties (loss of load) of springs made from OTEVA® 90 SC wire subjected to static compression at different temperatures, nitrided/not nitrided.