PENTHOR 954

Edition 04/2016
Replaces edition 01/2012

Oil tempered silicon/chromium/vanadium alloyed valve spring wire

External standard :
The material conforms to VDSiCrV according to EN 10270 - 2 : 2011

Further equivalent standards:
ASTM A877/877M Grade B

Applications :
Especially suitable for coil springs subjected to high dynamic stresses requiring good fatigue resistance (eg valve springs), as well as for springs which require high tensile strength and excellent relaxation properties at moderately elevated working temperatures (up to approx. 250 °C).

Range of diameters :
0.40 to 6.50 mm Ø

Chemical composition (heat analysis):

C %	Si %	Mn %	P max. %	S max. %	Cu max. %	Cr %	V %
0.50 - 0.70	1.20 - 1.65	0.40 - 0.90	0.020	0.020	0.06	0.50 - 1.00	0.10 - 0.25

Raw material :
Wire rod made of Si-killed steel according to in-house specifications.

Cleanliness acc. to max. t-method:
Number of non metallic inclusions in the surface area detected on end samples of the wire rod

Size of inclusions	5 - 10	>10 - 15	>15[1)]	µm
max. number/1000 mm²	50	7	0	

[1)] As stated by IVSWMA* it is likely to find occasional inclusions in valve spring quality steel of a size large than 15 µm

* IVSWMA: International Valve Spring Wire Manufacturers Association

Mechanical properties: Penthor 954 - Edition 04/2016 (replaces edition 01/2012)

<table>
<tr><th>Wire diameter

mm</th><th>Tolerance

mm</th><th>Tensile strength

MPa</th><th>Minimum reduction area
%</th><th>Minimum number of torsions
min.</th><th>Permissible depth of surf. defects [1)]</th><th>Permissible part.decarburi-zation depth [1)]</th></tr>
<tr><td>0.40 to 0.60</td><td rowspan="2">± 0.010</td><td>2230 to 2380</td><td rowspan="3">-</td><td>-</td><td colspan="2">max. 0.006 mm</td></tr>
<tr><td>> 0.60 to 0.80</td><td>2230 to 2380</td><td rowspan="2">5</td><td rowspan="15" colspan="2">max. 1.0%
of
wire diameter</td></tr>
<tr><td>> 0.80 to 1.00</td><td>± 0.015</td><td>2230 to 2380</td></tr>
<tr><td>> 1.00 to 1.30</td><td rowspan="3">± 0.020</td><td>2230 to 2380</td><td rowspan="5">50</td><td rowspan="3">5</td></tr>
<tr><td>> 1.30 to 1.40</td><td>2210 to 2360</td></tr>
<tr><td>> 1.40 to 1.60</td><td>2210 to 2360</td></tr>
<tr><td>> 1.60 to 2.00</td><td rowspan="3">± 0.025</td><td>2160 to 2310</td><td rowspan="6">4</td></tr>
<tr><td>> 2.00 to 2.50</td><td>2100 to 2250</td></tr>
<tr><td>> 2.50 to 2.70</td><td>2060 to 2210</td><td rowspan="6">45</td></tr>
<tr><td>> 2.70 to 3.00</td><td rowspan="4">± 0.030</td><td>2060 to 2210</td></tr>
<tr><td>> 3.00 to 3.20</td><td>2060 to 2210</td></tr>
<tr><td>> 3.20 to 3.50</td><td>2010 to 2160</td></tr>
<tr><td>> 3.50 to 4.00</td><td>2010 to 2160</td></tr>
<tr><td>> 4.00 to 4.20</td><td rowspan="4">± 0.035</td><td>1960 to 2110</td><td rowspan="4">3</td></tr>
<tr><td>> 4.20 to 4.50</td><td>1960 to 2110</td></tr>
<tr><td>> 4.50 to 4.70</td><td>1960 to 2110</td><td rowspan="2">40</td></tr>
<tr><td>> 4.70 to 5.00</td><td>1960 to 2110</td></tr>
<tr><td>> 5.00 to 5.60</td><td>1910 to 2060</td><td rowspan="3">35</td></tr>
<tr><td>> 5.60 to 6.00</td><td rowspan="2">± 0.040</td><td>1910 to 2060</td></tr>
<tr><td>> 6.00 to 6.50</td><td>1910 to 2060</td><td>-</td></tr>
</table>

a) Range of tensile strength within one coil max. 50 MPa
b) Ovality: Difference between the largest and smallest diameter of a cross section does not exceed 50 % of the diameter tolerance.
c) Yield point (0.2% limit) at least 90 % of the tensile strength
d) Modulus of elasticity E = 206.000 MPa
Shear modulus G = 79.500 MPa
} Standard
e)Torsion tests are carried out according to EN 10218 - 1
[1)] End samples

Surface inspection:
Wires with diameters from 2.5 to 6.50 mm are eddy current surface inspected after oil hardening and tempering using a combination of two methods to detect both transverse and longitudinal defects.
Testing of wires < 2.5 mm can be agreed upon separately.
Defects ≥ 40 µm are recorded and marked.
Based on type and shape a surface defect of more than 40 µm may not be detected by EC testing. See Position statement of IVSWMA.*

Heat treatment:
After coiling, the springs should be stress relieved as soon as possible at 380 - 425 °C, with a holding time of 30 minutes at temperature.
After shot peening, the springs must be stress relieved at approx. 240 °C for 30 minutes.

Shot peening:
The shot size and blast time must be chosen to ensure complete coverage of the inside of the springs.
Particular attention should be paid to the above in case of springs with small index and pitch.

Please inquire for special tolerances, tensiles, sections, etc.