Finemac™ Medical Datasheet
Free Cutting Wire

Zapp is certified according to ISO 9001

Finemac™ is a lead-free, hardenable, free-cutting carbon steel characterized by excellent machinability and high hardness, high wear resistance and exceptional dimensional stability after hardening. Hardening operations are very much simplified compared to 20AP, owing to the wider temperature and time range available using Finemac™. This results in significantly reduced failure rates during hardening. Finemac™ also exhibits very good cold heading properties. The material is suitable for long, narrow components with tight tolerances.

Service temperature -50 to 100°C (-55 to 210 °F). Prolonged service at elevated temperatures causes decreased hardness when used in the hardened and tempered condition.

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr
1.0	0.27	0.50	≤ 0.03	0.10	0.45

Forms of supply

Forms of supply/ finishes	Diameter mm	Cu-Sn coating	Standard tolerance	Length, m
Straightened wire				
Drawn	0.80 – 2.49	-	D4	-
	2.50 – 3.00	-	D3	2
	3.01 – 12.0	-	D2 3	2
Drawn/ground	0.80 – 3.00	-	h7	2
Drawn/ground	3.01 – 12.0	-	h7	3

Ovality: For D1 and D2, max. 50 % of the tolerance width: for D3 max. 25 % of the tolerance width: D4 ovality in accordance with the tolerance table below.

Diameter	Diameter tolerance				
mm	D1 +/-	D2 +/-	D3 +/-	D4 +/-	Ovality for D4
	mm	mm	mm	mm	mm
0.80 - 0.99	0.014	0.009	0.005	0.003	0.002
1.00 - 1.59	0.018	0.011	0.006	0.004	0.002
1.60 - 2.49	0.023	0.014	0.008	0.005	0.003
2.50 - 4.00	0.030	0.018	0.010	-	-
4.01 - 6.30	0.038	0.022	0.013	-	-
6.31 - 10.0	0.048	0.028	-	-	-
10.0 - 12.0	0.060	0.036	-	-	-

Impact strength

Observe that the quenching time and temperature are dependent on dimension. Specimens for the Charpy-V impact strength test are larger than standard wire dimensions.

Table of impact strength for Finemac™, hardened and quenched condition. See Figure 1.

Soaking temperature 810 °C (1,490 °F), soaking time: 4 min, tempering time: 30 min.

Tempering temperature, °C	Impact strength, J
100	3.0
200	3.7
300	3.0
400	4.3
500	6.0
600	13

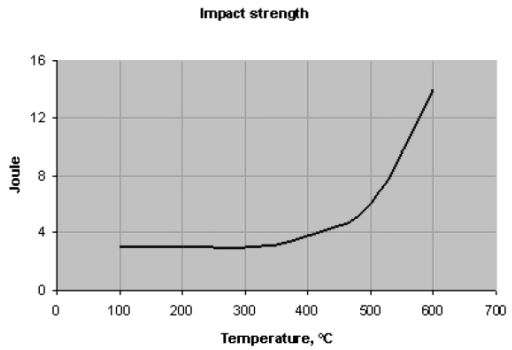

Figure 1. Impact strength after recommended hardening procedures, valid for all dimensions.

Soaking time 30 minutes. Standard Charpy-V specimens at 20oC (68oF).

Physical properties

Density	
Cast billets	7.8 g/cm³, 0.28 lb/in³
Resistivity	
Cold drawn and tempered	0.20 µΩm at 22 °C

Thermal expansion[1)]					
Temperature, °C	30 - 100	30 - 200	30 - 300	100 – 200	200 – 300
Cold drawn and tempered	11.0	12.0	13.0	12.5	14.5

[1)] Mean values in temperature ranges ($x10^{-6}$)

Finemac is a magnetic material.

Mechanical properties

Forms of supply/Finishes	Diameter tolerance	Tensile strength
	mm	R_m[1)]
		MPa
Wire in coils		
Drawn	0.80 - 3.00	> 980
Straightened wire		
Drawn	0.80 - 1.59	> 1000
Drawn/ground	1.60 - 3.00 0.80 - 3.00	> 980 > 980

[1)] Nominal values. Other properties on request.

Heart Treatment

Soft-annealing

When required, soft-annealing should be conducted for a period of one hour at a temperature of 650 - 680 °C (1200 - 1250 °F).

Hardening

Diameter	Temperature	Soaking time	Quenching
mm	°C	approx. min.	
≤ 5	800 - 820	3 – 6	in oil at 50 °C
➢ 5	790 – 810	6 - 10	in water

The smaller the diameter, the shorter the soaking time. To avoid oxidation and decarburization, hardening should be conducted in a protective gas atmosphere using nitrogen, argon or vacuum. Contact us for advice. Prolonged service at elevated temperatures causes decreased hardness when used in the hardened and tempered condition. See also Impact strength under Mechanical properties.

Tempering

Temperature, °C	100 - 600
Tempering time, min.	30 – 60

The core of the material needs a tempering time of at least 30 minutes. To reduce the risk of cracking, tempering should be conducted immediately after hardening. The heating rate should not be too high, particularly in the case of intricately shaped components.

Hardness

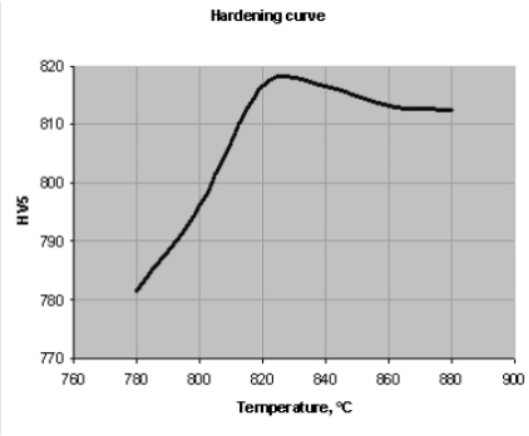

Figure 2. Hardness after quenching in oil at 50 °C (120 °F), valid for all dimensions.

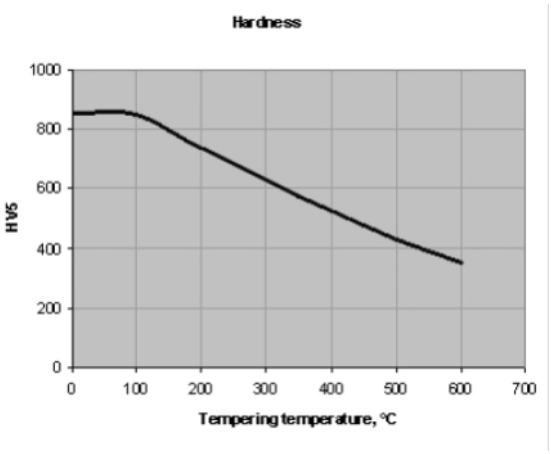

Figure 3. Hardness after recommended hardening and tempering procedures, valid for all dimensions.

Tempering time: 30 minutes.

Hardening operations

Hardening operations will be very much simplified compared to 20AP, owing to the wider temperature and time range available using Finemac™. Scrapping rates during hardening will be greatly reduced.

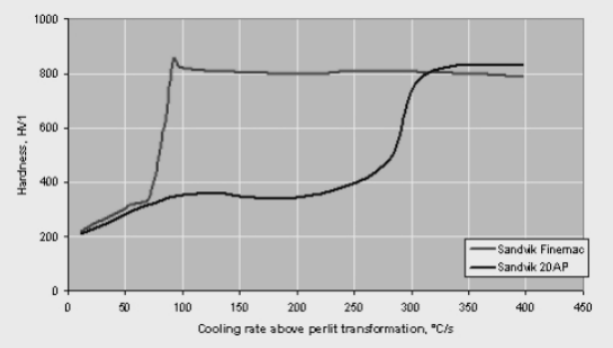

Figure 4. The cooling rate of Finemac™ vs. that of 20AP.

Machining

The recommended values, based on cemented carbide cutting tools or high-speed steel tools, are to be regarded as starting data. To obtain the optimal combination of finishes, tolerances and productivity the values should be adjusted for each individual operation. The data assume the use of a suitable cutting fluid. In machining without a cutting fluid, the values should be reduced by about 10 %.

In the manufacture of sophisticated precision components, the material's highly uniform and very good machinability offers reliable production with high productivity. This is of major importance since component processing costs can be several hundred times greater than the cost of the raw material.

Material in the drawn condition up to Ø 2.5 mm has a Cu/Sn surface layer. This layer enables components to be
machined with very high demands on dimensions due to the fact that the guide bushing can be set with very tight tolerances, thereby achieving high accuracy on the finished dimensions.

Turning

The charts below give guidance on how speed and feed affect diameter tolerances and surface roughness of turned components. The charts are based on longitudinal turning. The tolerances are given by using the ISO-system, i.e. IT7 could mean h7, k7 or js7.

The tools used in Figures 5 - 8 have been brazed, cemented carbide tools.

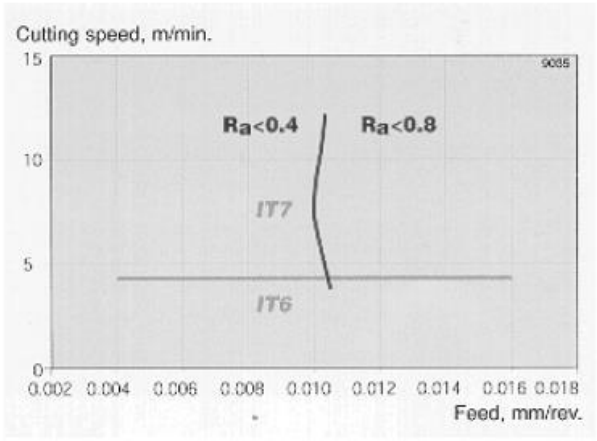

Figure 5. Wire diameter 1.20 mm, high tensile strength, drawn condition, depth of cut between 0.2 - 0.3 mm. Brazed cemented carbide.

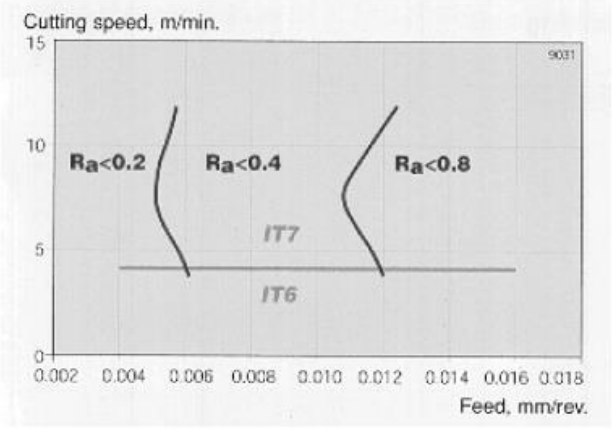

Figure 6. Wire diameter 1.20 mm, medium tensile strength, drawn condition depth of cut between 0.2 - 03 mm. Brazed cemented carbide.

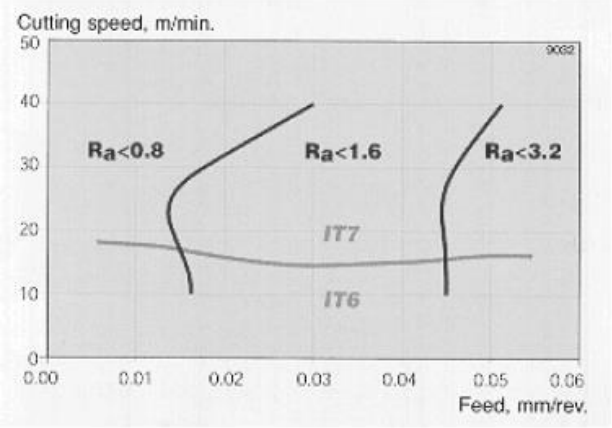

Figure 7. Wire diameter 3.00 mm, drawn condition, depth of cut between 0.4 - 0.6 mm. Brazed cemented carbide.

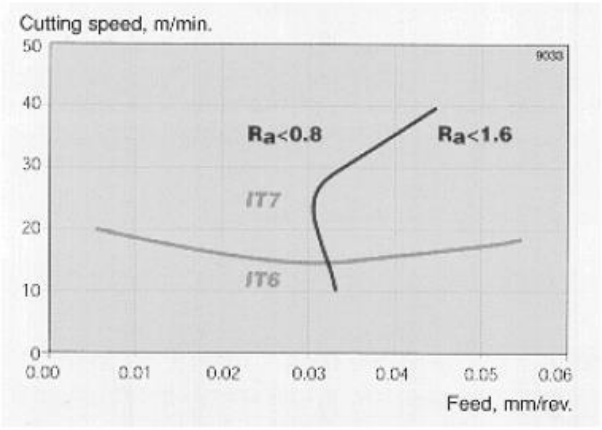

Figure 8. Wire diameter 3.50 mm, ground condition, depth of cut between 0.5 - 0.9 mm. Brazed cemented carbide.

Bar automatics

Diameter > approx. 2 mm

Tool	Cutting speed
	m/min.
CC	45 - 55
HSS	25 – 35

Longitudinal turning automatics, plunging automatics and similar machines

Operation	Cutting	Feed	Medium	
	depth	mm/rev.		
	Mm	Finish runing[1)]		Rough tuning
Single point turning	< 1	0.005 – 0.01	0.01 – 0.015	0.025
Forming	1 – 3	0.02 0.01	0.3 0.2	0.05 0.03
Plunge cutting and parting off	> 3	0.005 0.01	0.015 0.2	0.03 0.04

[1)]For parts requiring high precision.

[2)]For parts with moderate tolerance requirements and parts that subsequently must be finish machined.

Threading

Tool	Grade	Cutting speed
		m/mm.
Threading dies	HSS	3 – 6
Self-opening die heads	HSS	5 – 10
Thread chasers	HSS CC	20 – 35 30 - 50
Thread rolling	HSS CC	10 – 15 15 - 20

Drilling

Drill	Feed	Speed
Diameter, mm	mm/rev.	R_{pm}
0.5	0.005	2,650
1	0.01	2,500
3	0.03	1,500

End milling

Tool type	Grade	Cutting speed
	CC	m/mm.
Indexable insert tools	CC	40 – 60
Solid end mills	HSS CC	12 – 20 30 – 50
Brazed helical-fluted end mills	CC	30 - 40

Hobbing

Tool	Cutting speed
	m/min.
HSS	25 – 50
CC	30 - 60

Reaming

Cutting speed for diameters > about 2 mm

Reamer	Grade	Cutting speed
		m/min.
Straight/helical-fluted	HSS	10
Gun drill geometry	HSS CC	15 25

Feed

Feed	Allowance
mm/rev.	mm
0.05 – 0.10	0.05 – 0.10

All data are nominal. values refer to 20 °C (68 °F) unless otherwise stated.

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