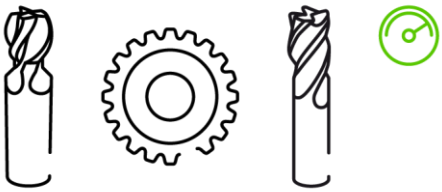
Z-M48 PM^{speed} Data Sheet
Tooling Alloys

Zapp is Certified to ISO 9001



Chemical Composition

Carbon	1.5 %
Chromium	3.8 %
Vanadium	3.1 %
Molybdenum	5.3 %
Tungsten	9.7 %
Cobalt	8.5 %

Z-M48 PM^{speed}

Z-M48 PM^{speed} is a „tough-hard “High Speed Steel grade. With its high attainable hardness level and compressive strength combined with an enhanced hot hardness and a good wear resistance. The material offers the perfect property profile for highly solicited cutting-, fine blanking and cold forming applications.

Z-M48 PM^{speed} is also successfully used for milling cutters for dry cutting or for rough milling of nickel and cobalt alloys.

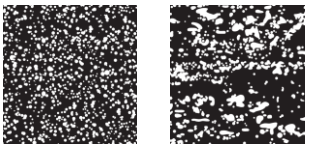
Typical Applications

- Cylindrical milling cutters
- End milling
- Broaches
- Reamers
- Thread taps
- Gear cutting tools
- Profile turning tools and furthermore

Physical Properties

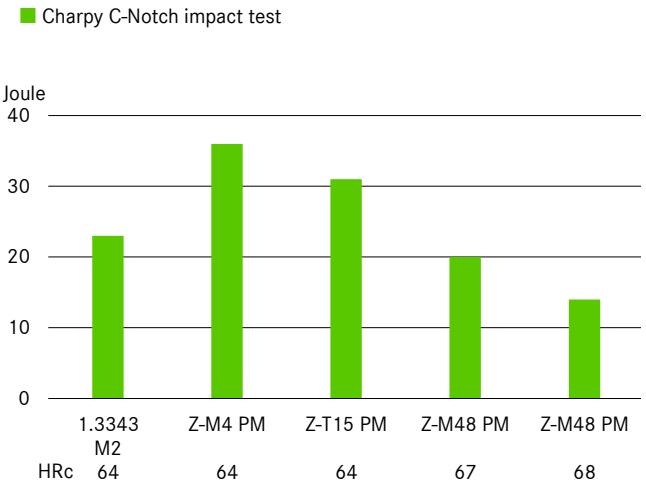
Modulus of elasticity E [GPa]	214
Density [kg/dm³]	8.26
Coefficient of thermal expansion [mm/mm/K] over temperature range of	
20 - 100 °C	10.7 x 10 $^{-6}$
20 - 200 °C	10.8 x 10 $^{-6}$
20 - 300 °C	11.1 x 10 $^{-6}$
20 - 425 °C	11.4 x 10 $^{-6}$
20 - 540 °C	11.7 x 10 $^{-6}$
Thermal conductivity [W/(m*K)] at 20 °C	24.2

Powder Metallurgical and Conventional Microstructure



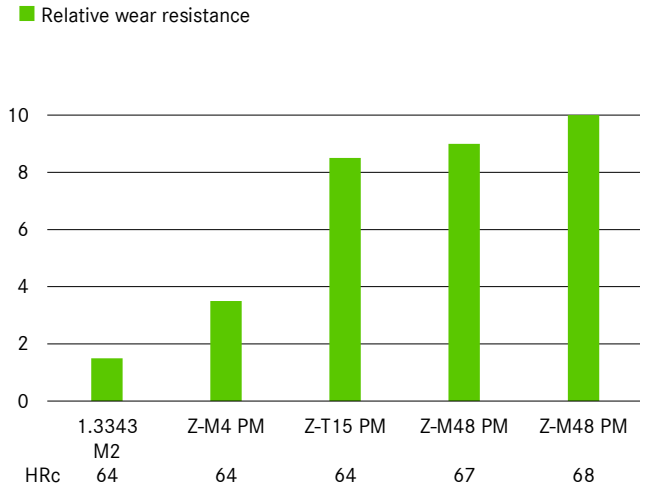
The uniform distribution of carbides in the powder- metallurgical structure compared to conventional tool steels with big carbides and carbide clusters.

Toughness



Standard size of the Charpy-test-piece with a 12.7 mm notch radius.

Wear Resistance



Heat Treatment Annealing

Soft Annealing
The material is heated uniformly to a temperature of 870 °C and then maintained at this temperature for 2 hours. Then, the material is cooled to 540 °C in a furnace at a cooling rate of maximum 10 °C per hour.

It is then further cooled in still air down to room temperature. The typical hardness achieved by soft annealing is approximately 310 HB.

Stress Relieving
Rough machined material is stress relieved by heating to 600 – 700 °C. Once complete heat penetration has been reached (minimum 2 hours), the material is allowed to cool in the furnace to approximately 500 °C followed by cooling in air.

Hardened material is stress relieved at 15 – 30°C for 2 hours below last tempering temperature followed by cooling in air.

Straightening
Straightening should be done in the temperature range of 200 – 430 °C.

Hardening
When hardening Z-M48 PM^{speed}, two preheating stages are usually used according to the table. Further preheating stages can be selected depending on the furnace type and charging.

For large cross-sections and high hardening temperatures, a further holding stage is recommended.
A well-balanced combination of wear resistance, toughness and hot hardness is achieved by austenitizing at 1,190 °C.

In order to achieve an appropriate degree of solution of the alloying elements and an adequate degree of quenching and tempering, adapted holding times are recommended in the different temperature ranges.

The holding times should be adjusted for large or very thin-walled tool cross-sections.

Quenching
Quenching can take place in hot bath at 540 °C, oil or pressurized gas. Quenching in salt bath or oil leads to maximum hardness, whereas cooling in vacuum can lead to lower values of 1 – 2 HRc.

By use of vacuum quenching a minimum pressure of 6 bar is recommended. The appropriate pressure needs to be adjusted for complex tool shapes in order to minimize risk of cracking and tool distortion.

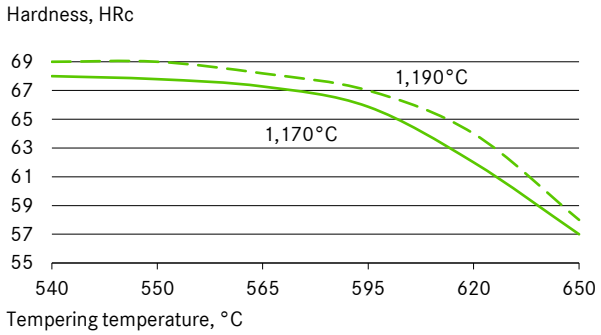
For attaining ideal toughness properties, it is recommended to apply the hot bath quenching method.

Tempering
Tempering should be carried out at minimum 540 °C immediately after the material has cooled down to below 40 °C or when the tool can be held with two hands.

Triple tempering with a holding time of 2 hours in each stage at the tempering temperature is necessary. It is important to ensure that the tools are cooled down to room temperature between the individual tempering stages.

Surface Treatments
Z-M48 PM^{speed} can be nitrided and/or PVD/CVD coated.

Tempering Diagram



Heat Treatment Instructions

1st preheating	450 - 500 °C
2nd preheating	850 - 900 °C
3rd preheating	1,000 – 1,050 °C
Hardening	as specified in table
Tempering	3 x each 2 hours as specified in table

Quenching after hardening in hot bath at approx. 550 °C or in vacuum at least at 6 bar overpressure.

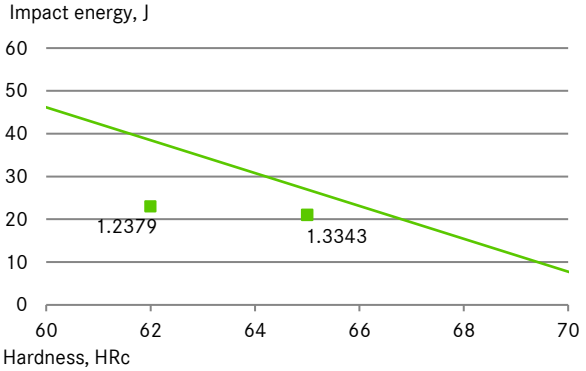
Required hardness HRc ± 1	**Austenitizing temperature °C**	**Minimum holding time at austenitizing temperature min.***	**Tempering temperature[°C]**
63	1,150	10	590
65	1,170	5	590
67	1,150	10	550
66	1,150**	10	565
66	1,190	5	590
68	1,170	5	540
67	1,170	5	565
69	1,190	5	540
68	1,190***	5	565
70	1,200	3	540

* In case of previous preheating at 870 °C. The data referred to 13 mm round bar samples. The holding times at austenitizing temperature should be correspondingly adapted for large and very thin profile dimensions. The maximum permissible austenitizing temperature of 1200 °C must not be exceeded.

** best toughness

*** best combination wear resistance/ toughness/ hot hardness

Toughness Values



Machining Data

Turning

Cutting parameter	Turning with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	80 - 110	110 - 140	8 - 10
Feed (f) mm/U	0.2 - 0,4	0.05 - 0.2	0.05 - 0.3
Cutting depth (a_p) mm	2 - 4	0.05 - 2	0.5 - 3
Tools according ISO	P 10–P 20*	P 10*	–

* Use wear resistant coated cemented carbide, e. g. Coromant 4015 or Seco TP 100.

Milling

Face- and edge milling

Cutting parameter	Milling with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	60 - 80	80 - 110	15
Feed (f) mm/U	0.2 - 0.3	0.1 - 0.2	0.1
Cutting depth (a_p) mm	2 - 4	1 - 2	1 - 2
Tools according ISO	K 15*	K 15*	–

* Use wear resistant coated cemented carbide, e.g. Coromant 4015 or Seco TP 100.

End milling

Cutting parameter	Solid carbide	Milling cutter w. indexable tips	Coated HSS
Cutting speed (V_C) m/min.	45 - 55	50 - 70	12*
Feed (f) mm/U	0.01 - 0.20**	0.06 - 0.20**	0.01 - 0.30**
Tools according ISO	K 20	P 25***	–

* for TiCN-coated end mills made of HSS V_C ~ 25-30 m/min.
** depends on radial depth of cut and on milling cutter - diameter
*** Use wear resistant coated cemented carbide, e.g. Coromant 3015 or SECO T15M.

Drilling

Spiral drill made of HSS

Driller-⌀ mm	Cutting speed (V_C) m/min.	Feed (f) mm/U
0– 5	12 - 16*	0.05 - 0.15
5 –10	12 - 16*	0.15 - 0.25
10 –15	12 - 16*	0.25 - 0.35
15 –20	12 - 16*	0.35 - 0.40

* for TiCN-coated end mills made of HSS V_C ~ 25-30 m/min.

Carbide metal driller

Cutting parameter	Drill type insert drill	Solid carbide tip	Coolant bore driller with carbide tip*
Cutting speed (V_C) m/min.	70 - 90	40 - 60	35
Feed (f) mm/U	0.08 - 0.14**	0.10 - 0.15**	0.10 - 0.20**

* driller with coolant bores and a soldered on carbide tip
** depends on driller-diameter

Grinding

Grinding method	Soft annealed	Hardened
Surface grinding, straight grinding wheels	A 13 HV	B 107 R75 B3* 3SG 46 GVS** A 46 GV
Surface grinding	A 24 GV	3SG 36 HVS**
Cylindrical grinding	A 60JV	B126 R75 B3* 3SG 60 KVS** A 60 IV
Internal grinding	A 46 JV	B126 R75 B3* 3SG 80 KVS** A 60 HV
Profile grinding	A 100 LV	B126 R100 B6* 5SG 80 KVS** A 120 JV

* for these applications we recommend CBN-wheels
** grinding wheel from the company Norton Co.

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