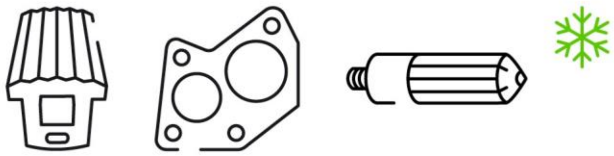
# Z-Tuff PM$^{cold}$ Data Sheet
# Tooling Alloys

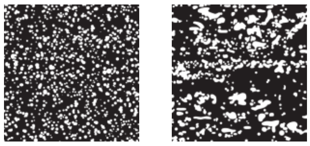
Zapp is Certified to ISO 9001



**Chemical Composition**

| | |
|---|---|
| Carbon | 0.7 % |
| Chromium | 7.5 % |
| Vanadium | 1.0 % |
| Molybdenum | 2.0 % |
| Nickel | 1.5 % |

**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.

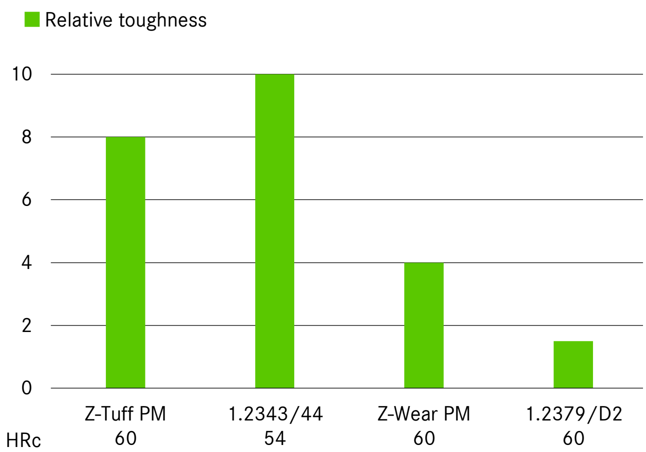
### Description

Z-Tuff PM$^{cold}$ is a powder metallurgy tool steel designed with toughness as the primary criteria. Its attributes include:

- High impact strength and resistance to fracture while retaining exceptional compressive strength
- Good wear resistance
- Attainable hardness approaching HRC 62
- Easily heat treated using common tool steel cycles
- Consistency and reliability inherent with PM tool steel
- Thermo-shock resistant

This unique combination of properties makes Z-Tuff PM$^{cold}$ the choice in difficult applications involving high mechanical loads and risk of failure due to chipping and fracture. It offers a distinct advantage over standard air hardening grades in terms of toughness.
At the same time it is clearly superior to the S series grades in terms of compressive strength and wear performance. It is a deep hardening grade that will maintain a high degree of dimensional stability, and a highly effective substrate for a variety of common tool coatings and surface treatments.

**Toughness**




### Typical Applications

- General tool and dies
- Stamping, forming and fine blanking
- Punches
- Powder compaction

**Physical Properties**

| | |
|---|---|
| Modulus of elasticity E [GPa] | 207 |
| Density [g/cm³] | 7.66 |
| Coefficient of thermal expansion over a temperature range of 20 - 540 °C [mm/(mm/K)] | 11.5 x $10^{-6}$ |
| Thermal conductivity [W/(m*K)] | 24.2 |

## Thermal Treatments

### Soft Annealing

The material is heated uniformly to a temperature of 860 – 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 15 °C per hour. It is then further cooled in still air down to room temperature. The typical hardness achieved by soft annealing is approximately 225 – 250 HB.

### Stress Relieving (soft)

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 Z-Tuff PMcold is hardened, two preheating stages are usually used as shown in the table. Further preheating stages can be added depending on the type of furnace and charging. For large cross-sections and high hardening temperatures, an additional preheating stage is recommended.

Hardening can be carried out in vacuum, salt bath or under protective gas atmosphere. Austenitizing is carried out between 1,010 °C and 1,070 °C. Higher hardening temperatures lead to higher wear resistance and hardness, while lower hardening temperatures result in improved toughness properties.

### Quenching

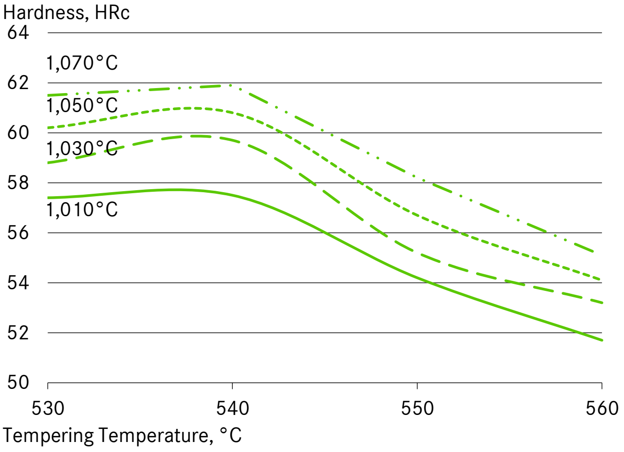
Quenching can take place in hot bath at 540°C, oil or pressurized gas. Quenching in salt bath or oil leads to maximum hardness, whereas cooling in vacuum can lead to lower values of 1 – 2 HRc. By use of vacuum quenching a minimum pressure of 6 bar is recommended. The appropriate pressure needs to be 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. For attaining maximum hardness after quenching the cooling rate between 1,000 °C and 700 °C needs to be maximized in order to minimize distortion in larger section sizes.

### Tempering

Tempering should be carried out immediately after the material has cooled down to below 40 °C. 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.

#### Tempering Diagram




#### Heat Treatment Instructions

| | |
|---|---|
| 1st preheating | 450-500°C |
| 2nd preheating | 850-900 °C |
| Hardening | as specified in table |
| Tempering | 3 x each 2 hours as specified in table |

Quenching after hardening in warm bath approx. 540 °C or in vacuum with at least 6 bar overpressure.

| Required hardness HRc ± 1 | Austenit-izing temp [°C] | Austenit-izing soak time [min]* | Tempering tempera-ture[°C] |
|---|---|---|---|
| 58 | 1,010 | 30 | 540 |
| 60 | 1,030 | 30 | 540 |
| 62 | 1,070 | 20 | 540 |

* If previous preheating was done at 870 °C. The data refer to the sample dimensions 13 mm rd. The holding times at hardening temperatures must be adjusted for large and very thin dimensions.

### Surface Treatment

Z-Tuff PM$^{cold}$ is an excellent base material for PVD and CVD coatings. Furthermore the application of a nitriding layer is also possible.

## Machining Data

### Turning

| Cutting parameter | Turning with cemented carbide medium turning | finish turning | HSS |
|---|---|---|---|
| Cutting speed ($V_C$) m/min. | 100-150 | 150-200 | 12-15 |
| 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. | 90-120 | 120-150 | 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 | 90-110 | 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 | 5 - 8* | 0.05–0.15 |
| 5 – 10 | 5 - 8* | 0.15–0.25 |
| 10 – 15 | 5 - 8* | 0.25–0.35 |
| 15 – 20 | 8 – 8* | 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. | 80–110 | 40 | 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*<br>3SG 46 GVS**<br>A 46 GV |
| Surface grinding | A 24 GV | 3SG 36 HVS** |
| Cylindrical grinding | A 60JV | B126 R75 B3*<br>3SG 60 KVS**<br>A 60 IV |
| Internal grinding | A 46 JV | B126 R75 B3*<br>3SG 80 KVS**<br>A 60 HV |
| Profile grinding | A 100 LV | B126 R100 B6*<br>5SG 80 KVS**<br>A 120 JV |

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

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