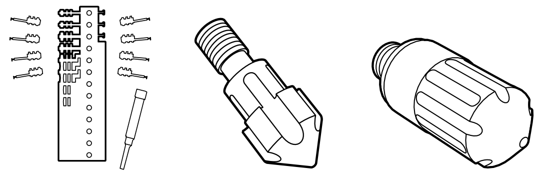
TOOLING ALLOYS
DATA SHEET Z-10 PM

ZAPP IS CERTIFIED TO ISO 9001



CHEMICAL COMPOSITIONS

Carbon	2.45 %
Chromium	5.25 %
Vanadium	9.75 %
Molybdenum	1.30 %
Manganese	0.50 %
Silicon	0.90 %

DESCRIPTION

Z-10 PM is a high vanadium cold work tool steel produced by powder metallurgy methods. Its highly alloyed, air hardening composition offers exceptional wear resistance along with good strength and toughness. This combination of properties can provide outstanding edge retention and extended tool life compared to standard tool steels grades such as D2 and M2. It is suitable for use in demanding applications involving long run, high production tools and abrasive part materials. The powder metallurgy process utilized provides well known benefits including more consistent machinability, grindability, heat treat response, and dimensional stability when compared to conventionally produced, high alloy grades.

TYPICAL APPLICATIONS

_ punches and dies

_ powder compaction tooling

_ cold forming tools

_ industrial knives

_ slitter blades

_ plastic processing components

_ granulator and pelletizer blades

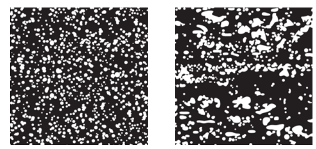
_ woodworking tools

_ wear parts

PHYSICAL PROPERTIES

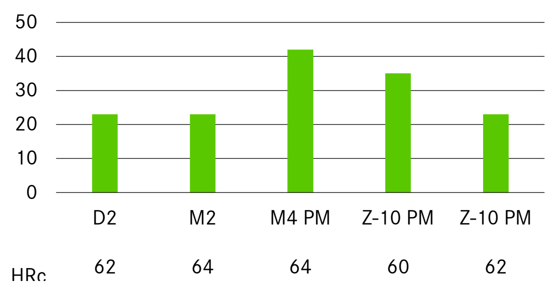
Modulus of elasticity E [psi x 10^6]	32
Density [lb/in³]	0.268
Coefficient of thermal expansion [in/in/ °F] Over a temperature range of 100 - 1100°F	6.82 x 10^{-6}

POWDER METALLURGICAL AND CONVENTIONAL MICROSTRUCTURE

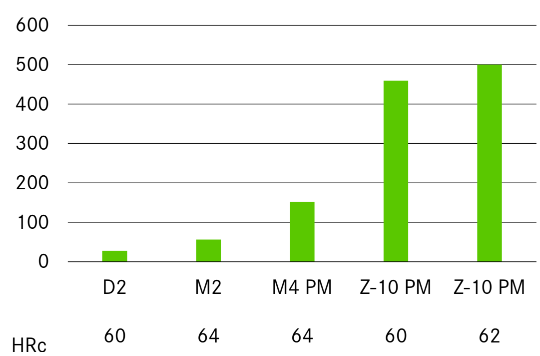


The uniform distribution of carbides in the powder metallurgical structure compared to conventional tool steels with big carbides and carbide clusters.

RELATIVE TOUGHNESS



RELATIVE WEAR RESISTANCE



Further information regarding our products and locations are available in our image brochure and under www.zapp.com

THERMAL PROCESSING

HARDENING
Vacuum, salt, or protective atmosphere methods are generally used. Care must be taken to prevent decarburization.

PREHEAT
Heat to 1,550-1,600°F (845-870°C) until temperature is equalized. Additional preheat steps including 1,250-1,300°F (680-700°C) and 1,850-1,900°F (1,010-1,040°C) are suggested when using programmed control during vacuum processing.

AUSTENITIZING
Temperatures in the range of 1,950°F (1,040°C) to 2,100°F (1,150°C) are commonly used with the specific temperature and soak time determined by the hardness required. Higher hardening temperatures will provide maximum wear resistance and hardness while temperatures lower in the range will provide increased toughness. Refer to chart for further information.

QUENCHING
Methods include use of high pressure gas (minimum 6 bar preferred), salt bath, or oil. Quench rate through the temperature range of 1,900°F (1,040°C) to 1,300°F (700°C) is critical to the development of optimum structure and properties. Part temperature can then be equalized at 1,000-1,100°F (540-595°C) after which cooling can continue to below 150°F (66°C) or "hand warm". Step quenching in this manner will help to minimize distortion in larger section sizes.

TEMPERING
Tempering should be performed immediately after quenching. Temperatures in the range of 1,000°F (540°C) to 1,100°F (595°C) are generally used depending on the hardness required. Heat uniformly to the selected temperature and soak for 2 hours. Triple tempering is essential. Tempering temperatures of less than 1,000°F (540°C) should not be used and care must be taken to cool parts fully to room temperature (hand warm) between each temper.

STRESS RELIEVING (HARD)
Heat to 25°F (15°C) less than the temperature of the last temper and soak for 1 hour.

SIZE CHANGE DURING HARDENING
+.0004 in/in (at HRc 60)

ANNEALING
Heat uniformly in a protective atmosphere (or vacuum) to 1,600°F (870°C) and soak for 2 hours. Slow cool 30°F (15°C) per hour until 1,000°F (540°C). Parts can then be cooled in air or furnace as Hardness expected is BHN 255-277.

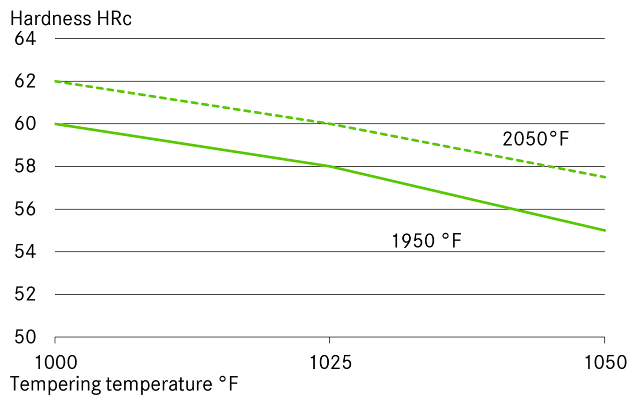
STRESS RELIEVING (SOFT)
Heat uniformly to 1,100-1,300°F (595-700°C), soak for 2 hours, and cool in air or furnace.

STRAIGHTENING
Should be done warm (or during quench) using temperatures in the range of 400°F (200°C) to 800°F (430°C).

CRITICAL TEMPERATURE
1,540°F (838°C).

SURFACE TREATMENT
This grade is an excellent substrate material for use with the various commercially available PVD coating processes. Conventional nitriding (.001" maximum depth) and steam tempering can also be used. Coating vendors should be consulted to select the optimum process for a given application. Care must be exercised during CVD and other surface treatment processes that can alter the original heat treatment of the tool.

TEMPERING DIAGRAM



HEAT TREATMENT INSTRUCTIONS

1st preheat	1,250-1,300°F
2nd preheat	1,550-1,600°F
Hardening	as specified in table
Tempering	2+2+2 hours at 1,000°F minimum

Preferred quench method is high pressure inert gas (minimum 6 bar) or molten salt at 1025°F.

Required hardness HRc	Austenitizing soak temp °F	Austenit-izing soak time [min]*	Tempering tempera-ture[°F]**
58-60 (max toughness)	1,950	30	1,000/ 1,025
60-62	2,050	20	1,000 / 1,025

* Process variation and part section size can affect results. Soak times should be based on actual part temperatures. Use of load thermocouples is highly recommended during batch processing.
**An increase in tempering temperature by 25°F can be used to reduce hardness 1 to 2 points HRc. Tempering temperatures less than 1,000°F should not be used.

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