



# LINDQUIST STEELS, INC.

## TOOL STEEL SPECIALISTS

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## TECHNICAL BULLETIN

### AISI M4 Powdered Metal

Typical Analysis:	Carbon	Mang.	Silicon	Chromium	Vanadium	Moly.	Sulphur
	1.37	0.35	0.40	4.25	4.00	4.50	0.07



Color Code: White with Gold Stripe

### CHARACTERISTICS

M4 Powdered Metal high speed steel is a special purpose grade of the molybdenum-tungsten family. Abrasion and wear resistance are enhanced by the increased carbon and vanadium content. Produced by the powder metallurgy process, M4 Powdered Metal achieves better grindability, added toughness and improved microstructure as compared with conventional wrought M4.

#### PHYSICAL PROPERTIES

**MODULUS OF ELASTICITY** (psi x 10<sup>6</sup>) — 31

**DENSITY** (lbs./cu. in.) — 0.286

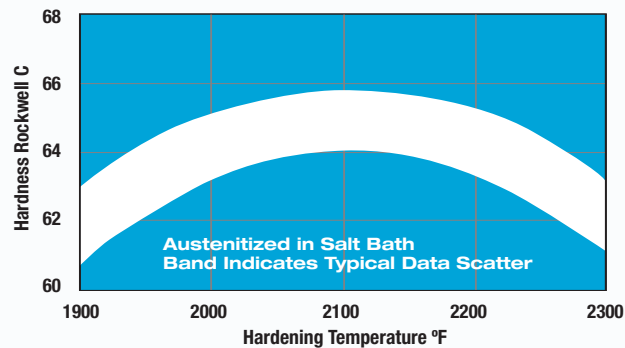
#### COEFFICIENT OF THERMAL EXPANSION

(in./in./°F x 10 <sup>-6</sup> ) of 100 to 600°F	— 5.66
100 to 800°F	— 6.24
100 to 1000°F	— 6.64
100 to 1200°F	— 6.82
100 to 1400°F	— 6.97
100 to 1500°F	— 6.99

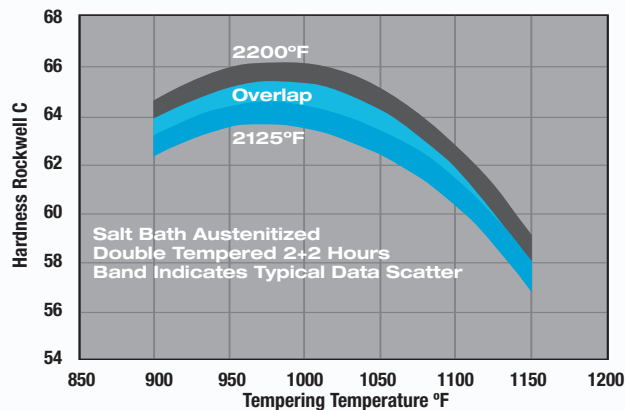
### GENERAL INSTRUCTIONS

**ANNEALING** — Pack anneal in sealed container to prevent excessive scaling or decarburization. Heat slowly to 1550 - 1600°F and hold at temperature for one hour per inch of container thickness. Then cool slowly with the furnace. A hardness of Brinell 255 or less should result.

**HARDENING** — Hardening in properly rectified salt baths or controlled atmosphere is recommended. When an open furnace is used, it is necessary to coat the tool with a protective material to prevent excessive decarburization. Preheat thoroughly at 1450 - 1550°F, then transfer to the high temperature salt bath or furnace. The exact hardening temperature to be used will depend on the tool being treated, but the general range is 2150 to 2225°F in a salt bath or 2175 to 2250°F if furnace hardening is employed. Allow sufficient soaking time for uniform heating, then quench into salt at 1000 to 1100°F or warm oil. If salt quenched, do not allow the bath temperature to exceed 1100°F; otherwise full hardness may not be attained. After equalizing at the quench bath temperature, complete the quench in still air down to at least 125°F, prior to beginning the tempering operation.



**TEMPERING** — M4 Powdered Metal should be tempered in the range of 1000 - 1100°F for most applications. Hold at temperature for 2 to 4 hours. Cooling should be carried out in still air and always allow tool to reach room temperature before retempering. Double or triple tempering is a recommended practice for longer tool life.



**GRINDABILITY** — Uniformly distributed carbide particles characteristic in the structure of M4 Powdered Metal result in significant grindability advantage. Improved grindability translates into lower manufacturing costs and greater productivity for tool makers. Easier metal removal from surfaces of hardened M4 Powdered Metal tools means less wheel wear, reduced surface damage and a potential for increased grinding feeds and speeds. The grindability of M4 Powdered Metal is significantly better than conventional wrought product.

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