

# NESSteel Inc

83 Gerber Drive, Tolland, CT 06084

800-654-2901 • Fax: (860) 875-4900 [sales@nessteel.com](mailto:sales@nessteel.com)

## Wear Resistant Tool Steel AISI M-2

M-2 is a tungsten-molybdenum high speed steel. M-2 is widely used in applications requiring a high degree of toughness, grindability, good wear resistance and high hardness. Typical analysis is shown in the chart below:

Carbon	Tungsten	Vanadium	Chromium	Molybdenum
0.85%	6.35%	1.9%	4.15%	5.0%

### Applications include:

- Lathe Tools
- Planer Tools
- Drills
- Taps
- Reamers
- Broaches
- Milling Cutters
- Form Cutters
- Thread Cutters
- End Mills
- Gear Cutters
- Wood Knives
- Blanking Dies
- Lamination Dies
- Gear Cutters
- Router Bits

### Heat Treatment

#### Forging:

- Preheat slowly to 1600° F until piece is thoroughly heated through, then increase heat to 1950°F - 2050°F.
- DO NOT hot work M-2 below 1700°F.
- After forging, allow M-2 to cool slowly, packed in lime or other insulating material. (For large forgings, let soak in large furnace at 1450°F, then cool in furnace.)
- Anneal as soon as possible.

#### Annealing

- Surface protection - Anneal in controlled atmosphere furnace or pack in an inert material.
- Slowly heat M-2 to 1550° - 1600°. Cool slowly at a rate of 20°F/hr until furnace is black. Shut down furnace, allow to cool normally. Annealed hardness range is 200 - 240 Brinell.
- **Stress-relieving:** Temperature 1100°F - 1290°F. Rough machine after stress relieving. Hold tool for 2 hours after reaching full temperature. Cool in furnace to 930°F and then air-cool.

#### Hardening:

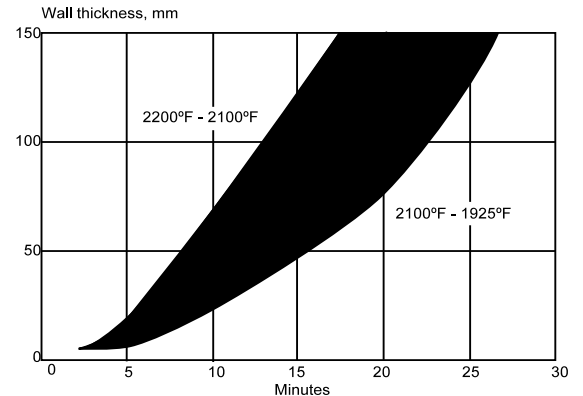
- For best results, harden M-2 in salt baths or controlled atmosphere furnaces.
- Pre-heat slowly to 1450°F - 1550°F, and ensure equal temperature throughout the piece.
- Transfer piece to high-temp bath or furnace.
- Hold steel at temperature depending on M-2 use:  
Single-edge cutting tools: 2175°F - 2225°F (salt bath)  
2200°F - 2250°F (furnace)

Rotating multi-edge cutting tools: 2150°F - 2200°F

Punches, dies, etc: 1920°F - 2100°F

- After holding at hardening temperature for the appropriate time, quench immediately into salt at 1000°F - 1100°F or warm oil. Allow temperature equalization to occur if using salt bath; if oil quenched, remove at 900°F and air cool.

#### Heating Time in Salt Bath (after equalization):



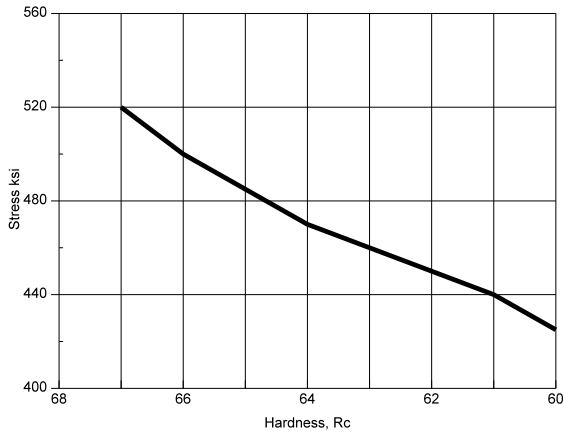
#### Tempering

- Temper immediately when piece reaches 150°F or when comfortably hand-held.
- Tempering temperature should be in the range of 1025°F - 1100°F.
- Heat slowly to temperature, hold tools at heat for 2 hours before air cooling.
- For best toughness, after tool has cooled, retemper for 2 additional hours at slightly lower temperature.

**Tempering Graph:**

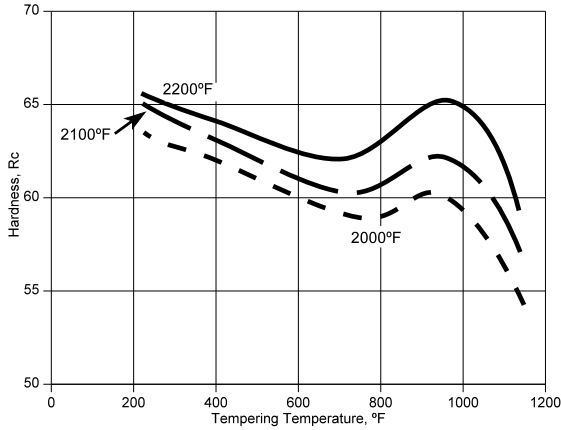
**Physical & Mechanical Properties (approx)**

- Density, lb per cu in: .294
- Specific gravity 8.15
- Critical points:  
Heating (Ac) 400°/hr - begins 1530°F; ends 1618°F

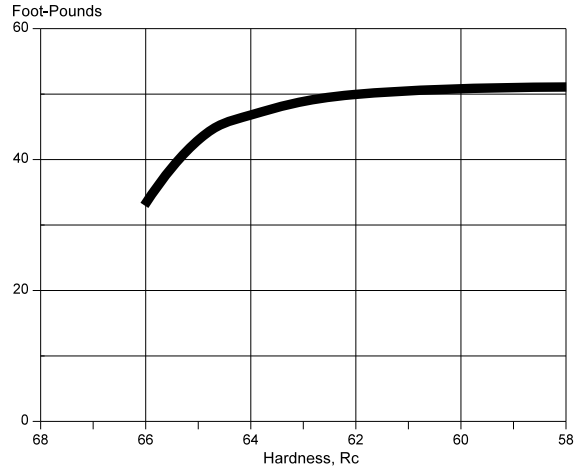


Cooling (Ar) 30°/hr - begins 1430°F; ends 1380°F

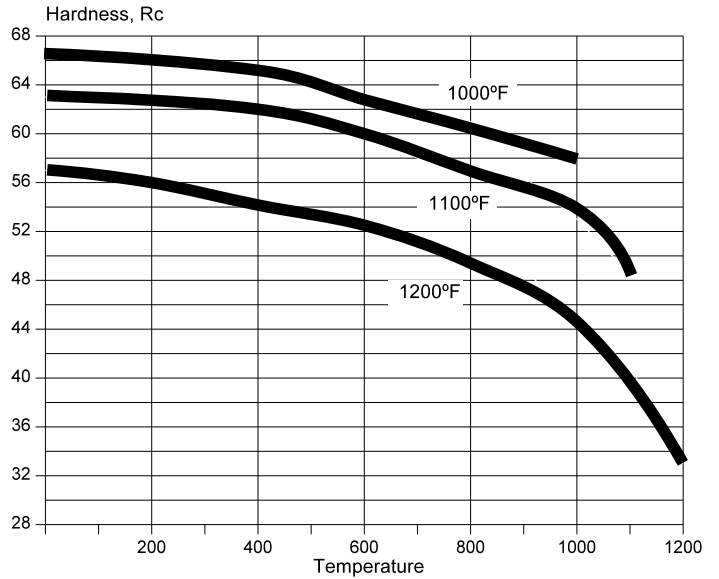
**Typical Yield Strength In Compression**



**Unnotched IZOD Impact**



**Typical Hot Hardness**



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