Technical Datasheet

CarTech® M-50 Bearing Steel

Identification

UNS Number

• K88165

AISI Number

• Type M-50

Type Analysis

Single figures are nominal except where noted.

Carbon	0.80 %	**Manganese**	0.25 %
Phosphorus	0.015 %	**Sulfur**	0.015 %
Silicon	0.25 %	**Chromium**	4.00 %
Nickel	0.10 %	**Molybdenum**	4.50 %
Vanadium	1.00 %	**Iron**	Balance

General Information

Description

CarTech M-50 Bearing Steel, which is refined using vacuum-induction melting (VIM) and vacuum-arc remelting (VAR) processes, exhibits excellent resistance to multi-axial stresses and softening at high service temperatures as well as good resistance to oxidation. Characteristic of a high-speed tool steel, it possesses high compressive strength.

Due to the alloy's high degree of cleanliness, parts are capable of being finished to a high luster.

Applications

CarTech M-50 Bearing Steel has been used in a wide variety of applications in the bearing and missile industry for components which require high wear resistance and strength at elevated temperatures. It has been used for bearings in aircraft and gas turbine engines operating at service temperatures up to about 700°F (371°C).

This alloy could also be considered for use in tooling applications where high levels of performance are required.

Properties

Physical Properties

Density	0.2880	lb/in³
Mean CTE		
-100 to 70°F	5.59	x 10 $^{-6}$ in/in/°F
70 to 200°F	6.23	x 10 $^{-6}$ in/in/°F
70 to 500°F	6.72	x 10 $^{-6}$ in/in/°F
70 to 1000°F	7.38	x 10 $^{-6}$ in/in/°F

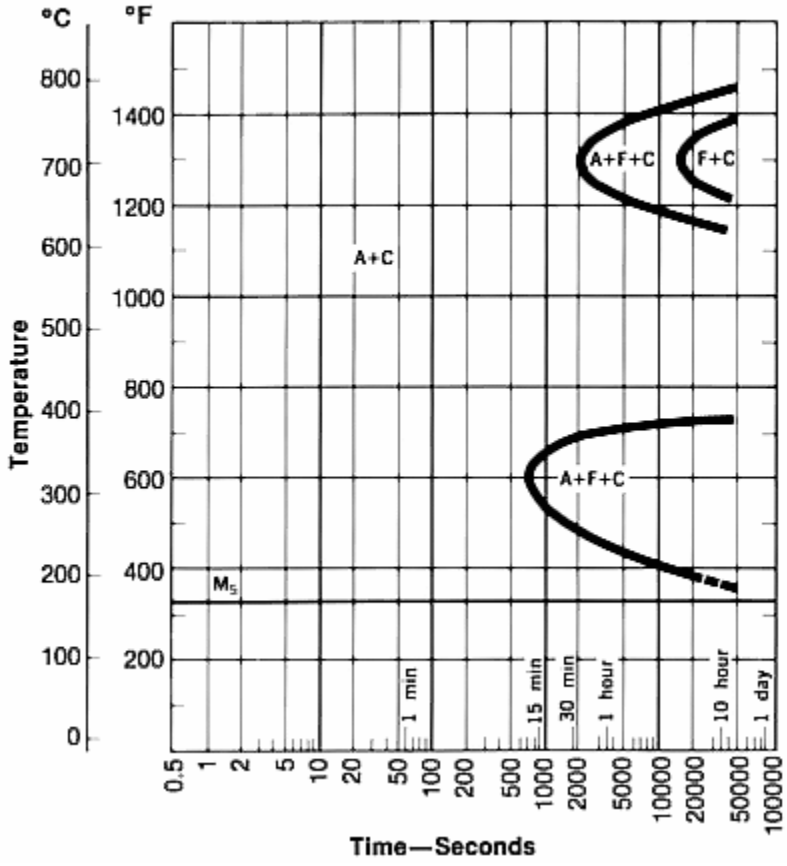
Mean coefficient of thermal expansion

°F	°C	10⁻⁶/°F	10⁻⁶/°C
-100 to 70	-73 to 21	5.59	10.1
70 to 200	21 to 93	6.23	11.2
70 to 500	21 to 260	6.72	12.1
70 to 1000	21 to 538	7.38	13.3

Modulus of Elasticity (E)	29.5	x 10 ^{3} ksi

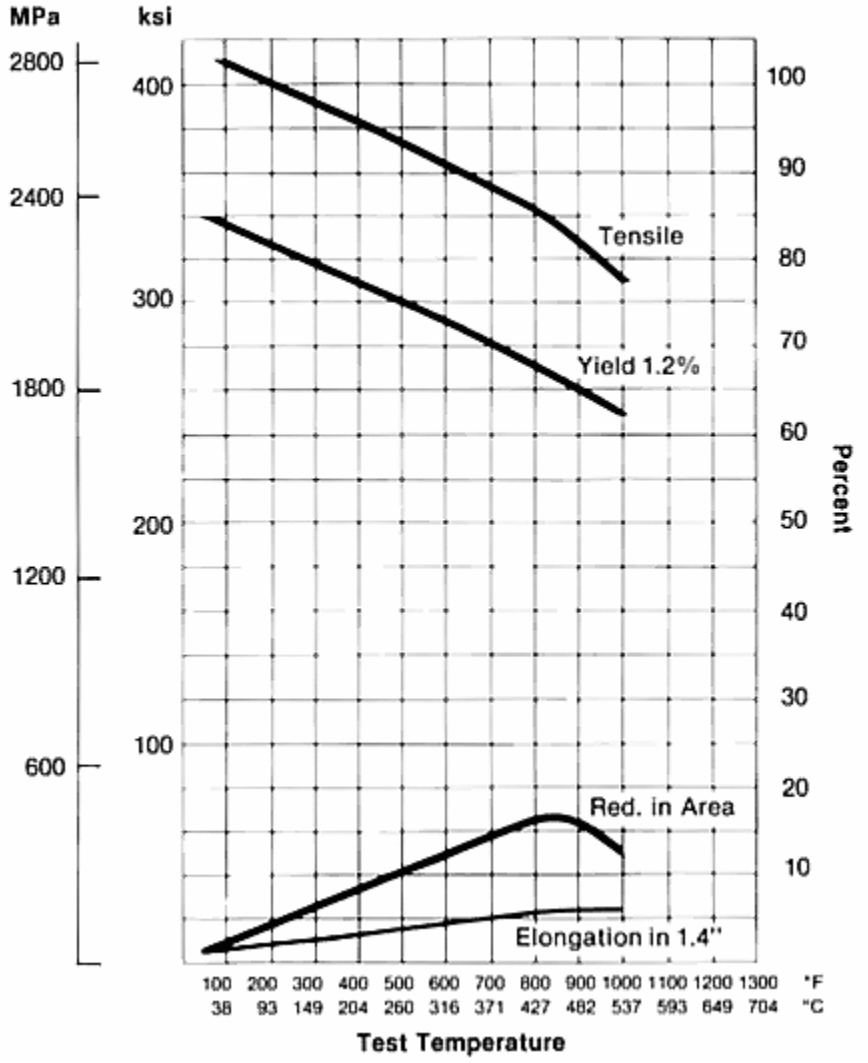
Isothermal Transformation Diagram for Carpenter VIM-VAR M-50 Bearing Steel

Austenitizing temperature—2050°F (1121°C)

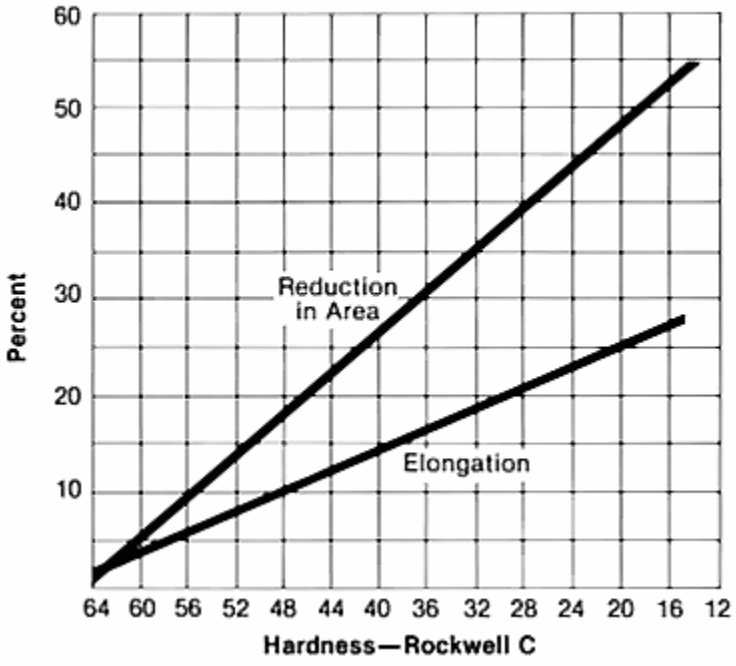


Typical Mechanical Properties

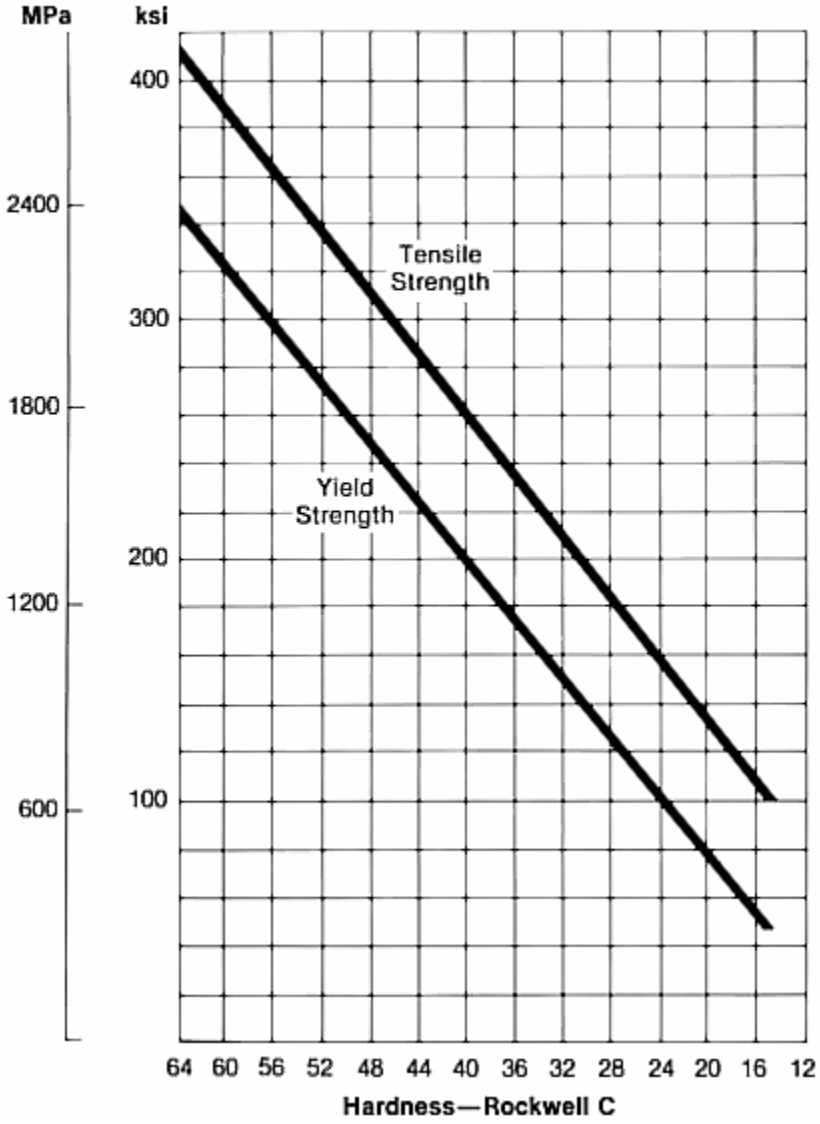
Hot Tensile Properties of Carpenter VIM-VAR M-50 Bearing Steel



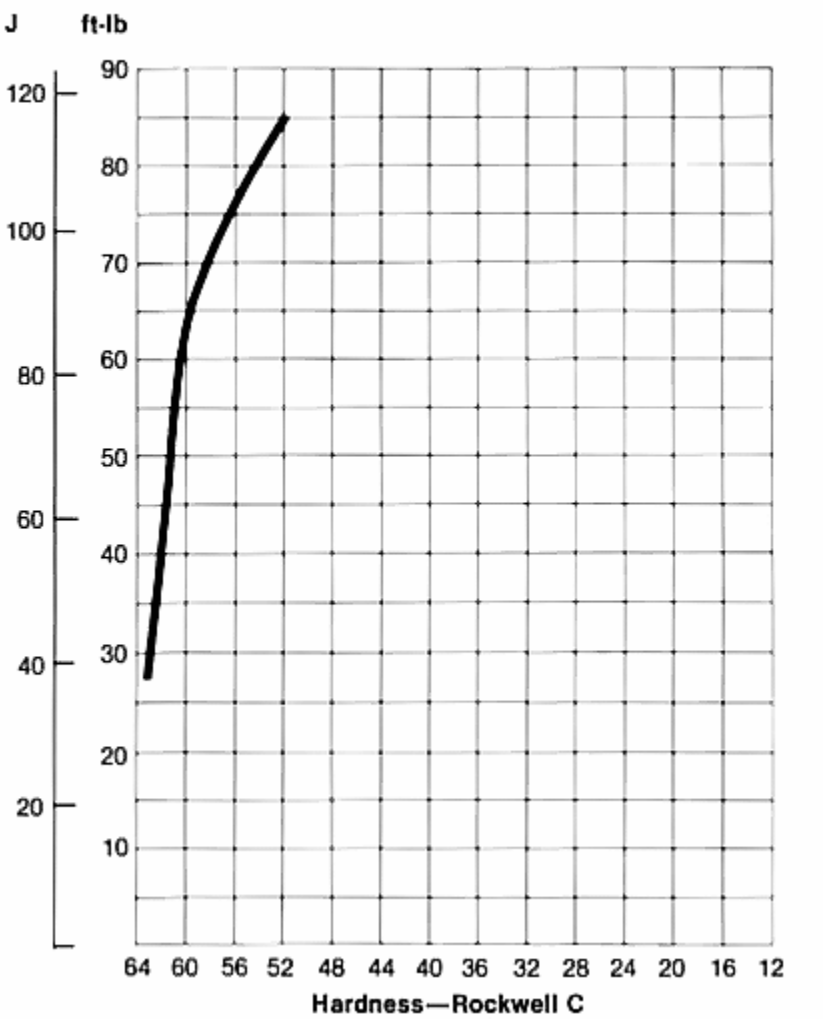
Reduction in Area and Elongation (in 2") of Carpenter VIM-VAR M-50 Bearing Steel



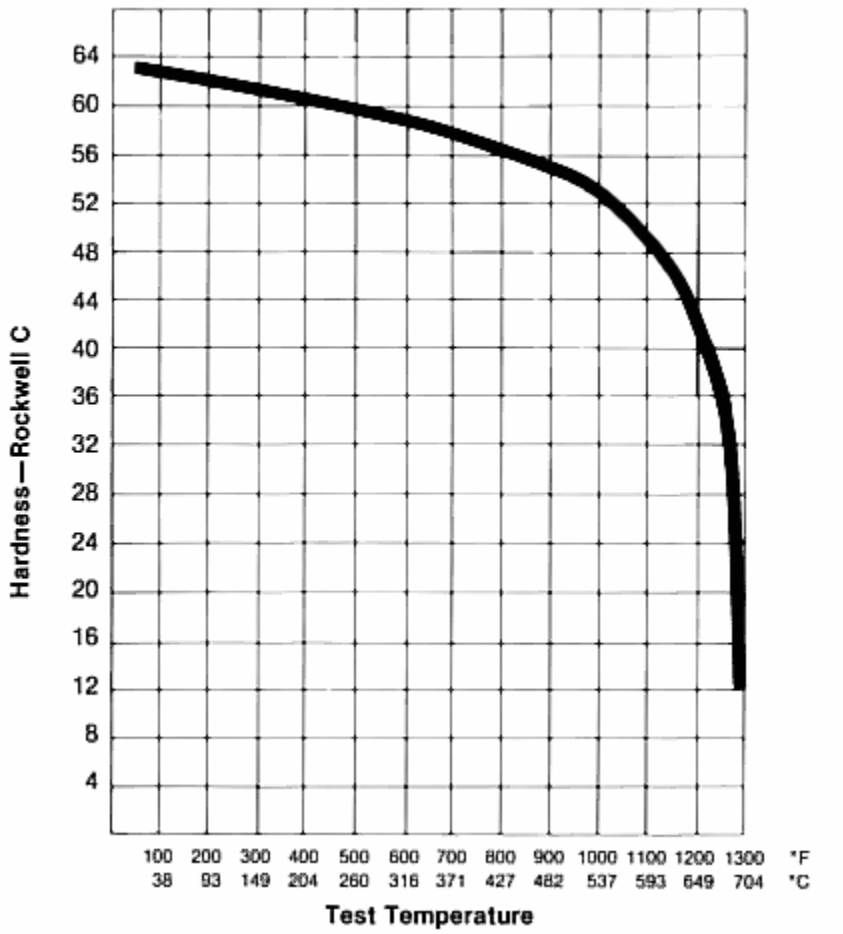
Tensile Strength and Yield Strength (0.2% Offset) of Carpenter VIM-VAR M-50 Bearing Steel



Un-notched Izod Impact Strength of Carpenter VIM-VAR M-50 Bearing Steel



Hot Hardness Properties of Carpenter VIM-VAR M-50 Bearing Steel



Heat Treatment

Decarburization

Since VIM-VAR M-50 Bearing Steel must be heat treated from a relatively high temperature, it must be protected from changes in surface chemistry during the hardening operation. This is best done by treating from neutral salt baths or from controlled atmosphere furnaces. A dew point of 15 to 20°F (-9.4 to -6.7°C) is usually satisfactory to prevent decarburization during hardening.

Normalizing

Normalizing is not recommended for VIM-VAR M-50 Bearing Steel.

Annealing

Heat uniformly to 1550/1650°F (843/899°C), hold at heat for one hour per inch of thickness, then cool slowly in the furnace at a rate of no more than 20°F (11°C) per hour. The slow cooling rate should be maintained until the parts are black.

Keep in mind that VIM-VAR M-50 Bearing Steel is subject to decarburization and therefore must be protected either by packing in suitable containers with clean cast-iron borings or by annealing in a controlled atmosphere furnace.

Hardening

The following is a specific recommendation for heat treating to produce optimum stability:

Preheat at 1500°F (816°C) and equalize, then transfer to superheated furnace at 2010 °F (1100 °C). Superheat only long enough to allow the piece to reach superheated furnace temperature and follow immediately by quenching to room temperature. Following quenching, cool the part to approximately -100°F (-73°C). Following cooling, double temper at 1000° F (538 °C). This should produce a hardness of Rockwell C 62-64 and optimum stability so far as size change during service is concerned.

An additional general hardening recommendation would be to preheat to 1500/1600°F (816/871°C), followed by superheating from 2000/2050°F (1093/1121°C). The parts may be oil, air or high temperature salt quenched.

Deformation (Size Change) in Hardening

The size change in hardening characteristics exhibited by VIM-VAR M-50 Bearing Steel are similar to those displayed by other more common high-speed-type steels.

Generally, a small amount of growth can be expected as hardened, and a return to almost zero after proper tempering.

The alloy will show less size change and warpage if it is air hardened, although oil hardening and salt quenching are the more commonly used practices.

Tempering

Temper immediately after the pieces have been cooled in the quench. The normal tempering range is from 975/1025°F (525/552°C). Double tempering is desirable with two hours at heat being the recommended time for each temper. The pieces should be cooled back to room temperature between tempers.

The hyperlink entitled "Effect of Tempering" shows the results of hardening and double tempering at specific temperatures.

Effect of Tempering Carpenter VIM-VAR M-50 Bearing Steel
Austenitized at 2025°F (1107°C), oil quenched, double tempered—2 hours each

Tempering Temperature		Hardness Rockwell C
°F	°C	
As quenched		64/65
900	482	60/62
950	510	61/63
1000	538	62/64
1050	566	61/63
1100	593	60/62
1150	621	55/58
1200	649	53/56

Workability

Forging

Preheat to 1400/1500°F (760/816°C) and allow pieces to equalize, then increase the furnace temperature to 1950/2050°F (1066/1121°C). Do not forge below 1800°F (982°C). Reheat as often as required to maintain forging temperature.

After forging, pieces may be cooled in the furnace or in lime or ashes. When cooled, the forgings should be annealed.

Machinability

VIM-VAR M-50 Bearing Steel is normally machined in the fully annealed condition at a maximum hardness of 229 Brinell. In this condition, it has a machinability rating of approximately 65% of AISI 1095 or 50% of AISI B1112 steel. Sulfurized mineral oil is recommended for use as a cutting fluid in most cases.

Other Information

Applicable Specifications

- AMS 6490
- AMS 6491

Forms Manufactured

- Bar-Rounds
- Billet
- Wire
- Wire-Shapes

Edition Date: 03/01/1991