Technical Datasheet

CARPENTER

Unit Display: Metric

Print Now

E-Mail Datasheet
Add to My Materials
Request More Information

AerMet® 100 Alloy

Identification

U.S. Patent Number

- 5,087,415
- 5,268,044

UNS Number

- K92580

Type Analysis

Carbon	0.23 %	**Chromium**	3.10 %
Nickel	11.10 %	**Molybdenum**	1.20 %
Cobalt	13.40 %	**Iron**	Balance

General Information

Description

AerMet® 100 alloy is an alloy possessing high hardness and strength combined with exceptional ductility and toughness.

The alloy is designed for components requiring high strength, high fracture toughness and exceptional resistance to stress corrosion cracking and fatigue.

Applications

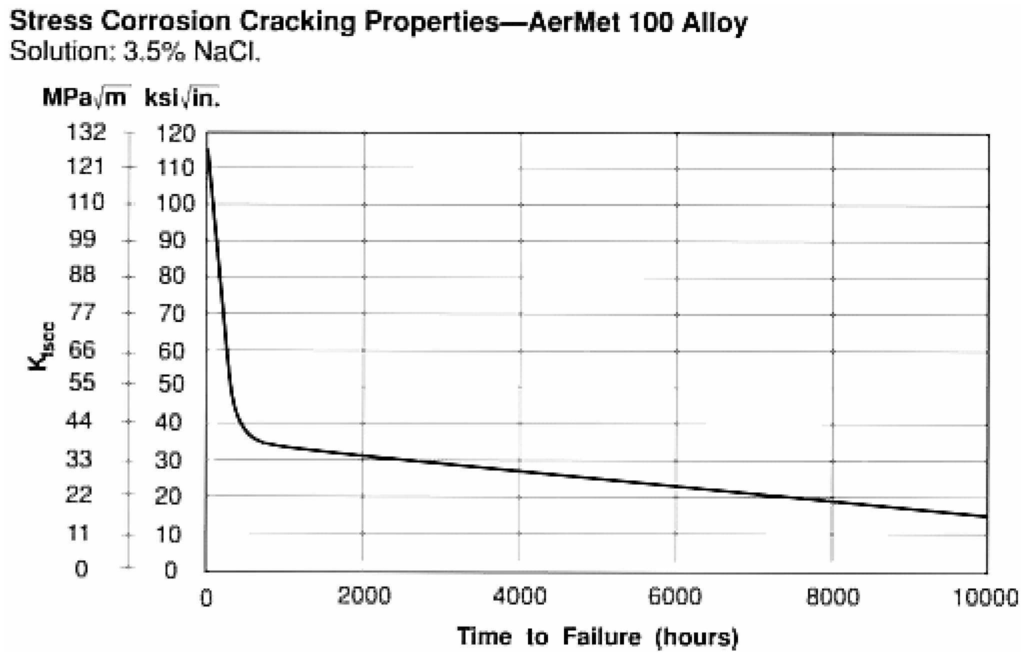
AerMet 100 alloy can be considered as a candidate for use in applications such as:

Armor
Fasteners
Landing gear
Actuators
Ordnance
Ballistic tolerant components
Jet engine shafts
Structural members
Drive shafts
Structural tubing

Corrosion Resistance

Important Note: *The following 4-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors which affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish and dissimilar metal contact.*

Humidity	Restricted	



Properties

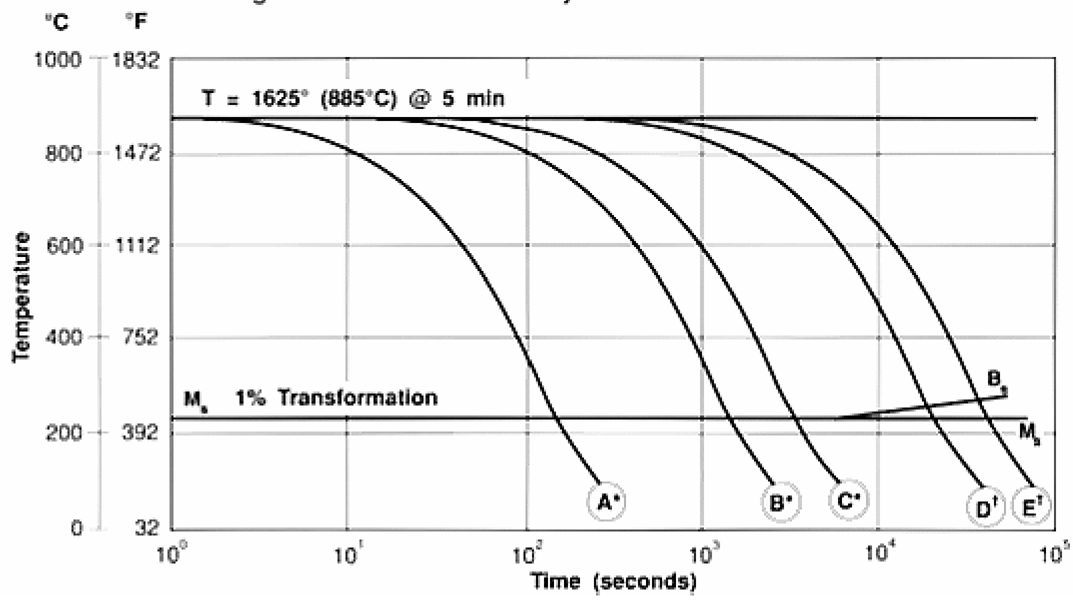
Physical Properties	
Density	
--	7889 kg/m³
Mean CTE	
24 to 93°C, Annealed	9.88 x 10^{-6} cm/cm/°C
24 to 149°C, Annealed	10.3 x 10^{-6} cm/cm/°C
24 to 204°C, Annealed	10.5 x 10^{-6} cm/cm/°C
24 to 260°C, Annealed	10.7 x 10^{-6} cm/cm/°C
24 to 316°C, Annealed	10.8 x 10^{-6} cm/cm/°C
24 to 371°C, Annealed	11.0 x 10^{-6} cm/cm/°C
24 to 427°C, Annealed	11.2 x 10^{-6} cm/cm/°C
24 to 482°C, Annealed	11.3 x 10^{-6} cm/cm/°C
24 to 538°C, Annealed	11.3 x 10^{-6} cm/cm/°C
24 to 93°C, Heat Treated	9.99 x 10^{-6} cm/cm/°C
24 to 149°C, Heat Treated	10.4 x 10^{-6} cm/cm/°C
24 to 204°C, Heat Treated	10.6 x 10^{-6} cm/cm/°C
24 to 260°C, Heat Treated	10.8 x 10^{-6} cm/cm/°C
24 to 316°C, Heat Treated	10.9 x 10^{-6} cm/cm/°C
24 to 371°C, Heat Treated	11.1 x 10^{-6} cm/cm/°C
24 to 427°C, Heat Treated	11.3 x 10^{-6} cm/cm/°C
24 to 482°C, Heat Treated	11.4 x 10^{-6} cm/cm/°C
24 to 538°C, Heat Treated	11.6 x 10^{-6} cm/cm/°C

Mean coefficient of thermal expansion

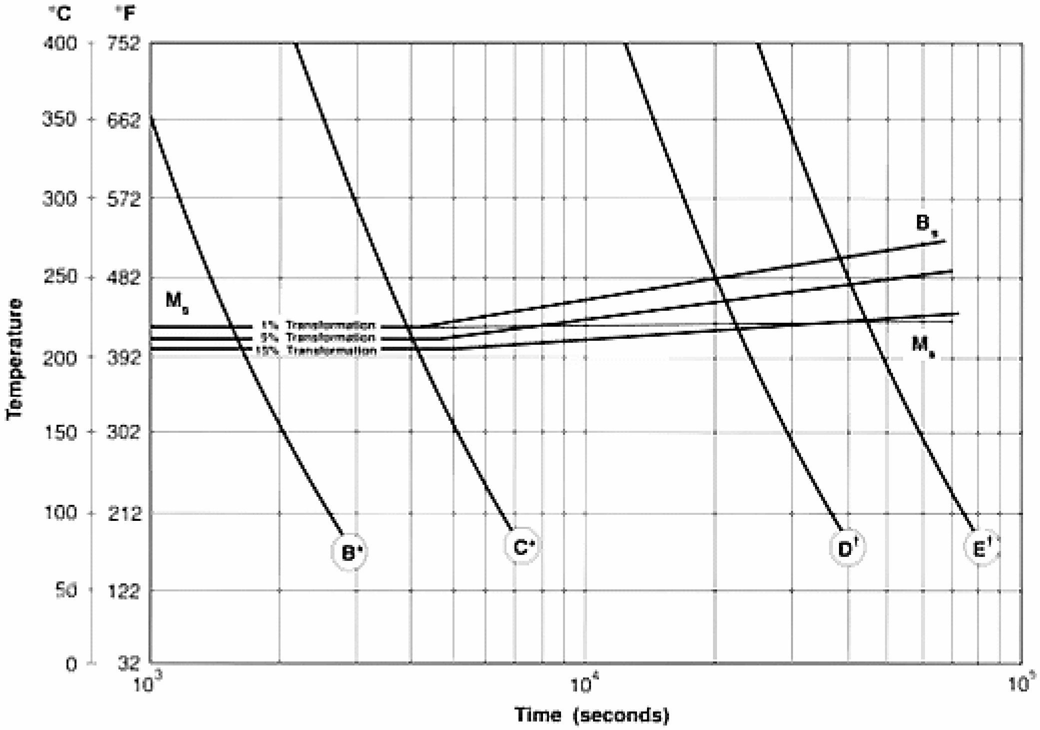
Temperature Range		Condition			
		Annealed		Heat Treated	
75°F to (°F)	25°C to (°C)	x 10^{-6}/°F	x 10^{-6}/°C	x 10^{-6}/°F	x 10^{-6}/°C
200	93	5.49	9.88	5.55	9.99
300	149	5.73	10.31	5.77	10.39
400	204	5.83	10.49	5.88	10.58
500	260	5.92	10.66	6.00	10.80
600	316	6.01	10.82	6.08	10.94
700	371	6.10	10.98	6.16	11.09
800	427	6.20	11.16	6.25	11.25
900	482	6.29	11.32	6.34	11.41
1000	538	6.28	11.30	6.43	11.57

Modulus of Elasticity (E)	
--	194 x 10^3 MPa
Electrical Resistivity	
21°C	430.5 micro-ohm-mm
Critical Temperature (AC1)	
--	573.9 °C
Critical Temperature (AC3)	
--	829.4 °C

Full continuous cooling curve—AerMer 100 alloy



Partial continuous cooling curve—AerMet 100 alloy
This partial curve represents a critical region of the continuous cooling curve as well as the inclusion of 5 and 15% transformation lines.



* .12" (3 mm) diameter x .39" (10 mm) rod heated to 1625°F (885°C) at 360°F (200°C) per minute held at 1625°F (885°C) for 5 min quenched with helium gas.

† .12" (3 mm) diameter x .31" (8 mm) rod heated to 1625°F (885°C) at 360°F (200°C) per minute held at 1625°F (885°C) for 5 min quenched with helium gas.

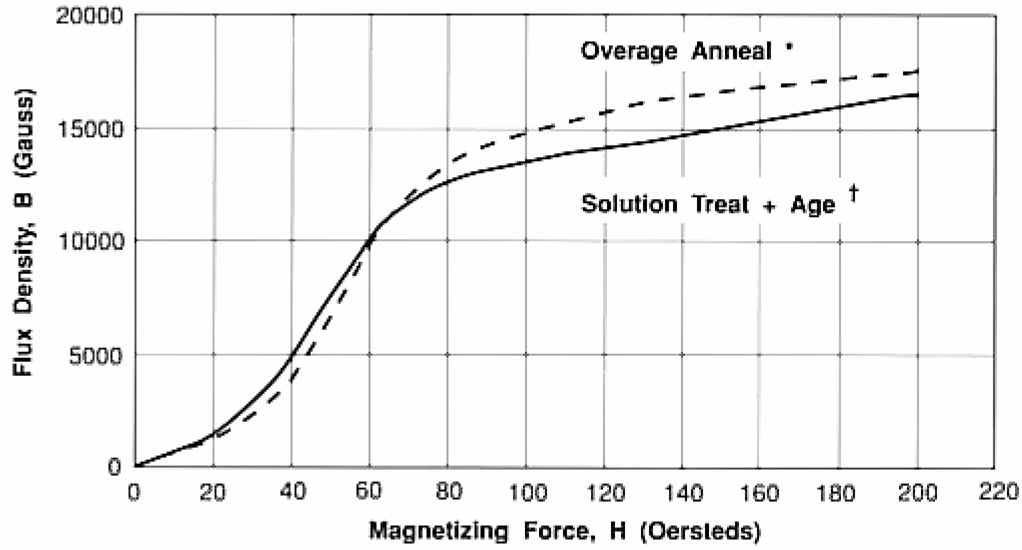
The following chart contains a summary of the data from the partial continuous cooling curve.

Sample ID	Cooling Time Seconds	M_s		B_s		Hardness HRC
		°F	°C	°F	°C	
A	200	437	225	–	–	55.5
B	2000	437	225	–	–	53.0
C	5000	437	225	–	–	52.5
D	28800	428	220	482	250	51.5
E	57600	423	217	500	260	51.5

Magnetic Properties

DC Normal Magnetic Properties—AerMet 100 Alloy

Overage annealed material - 1250°F (677°C) 16 hours, air cooled.
Solution treated and aged material - 1625°F (885°C) 1 hour, air cooled, refrigerated -100°F (-73°C), aged 900°F (482°C) 5 hours, air cooled.

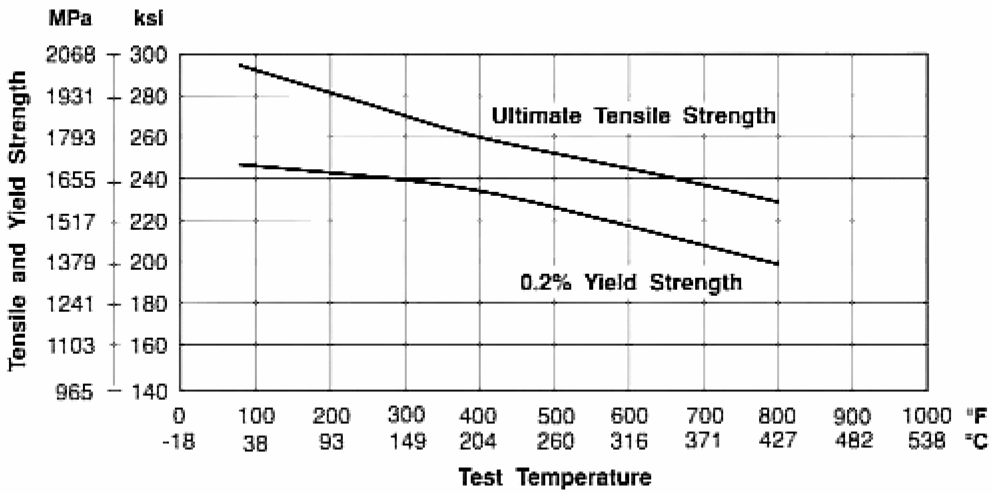


* μ max = 180, From H = 200 Oe, B_r = 11600 G, H_c = 52.0 Oe
† μ max = 150, From H = 200 Oe, B_r = 10100 G, H_c = 39.5 Oe

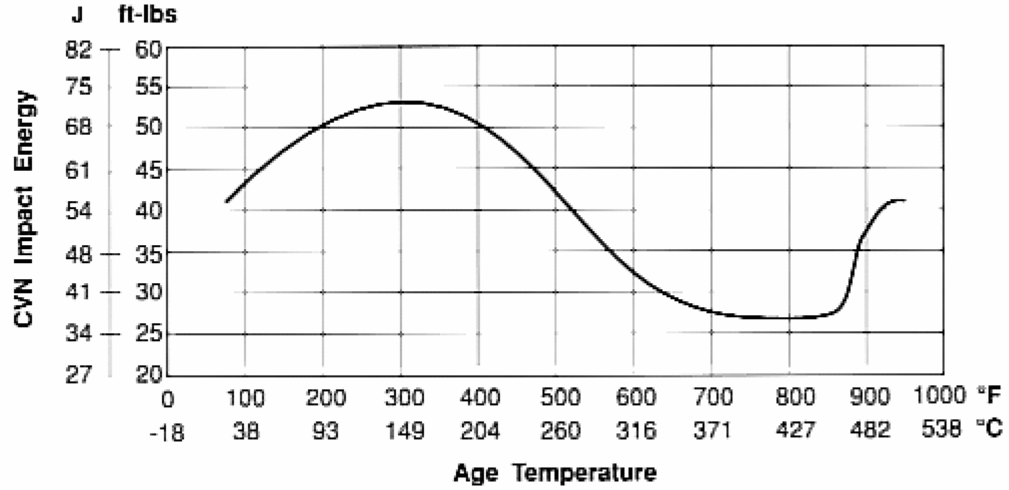
Typical Mechanical Properties

0.2% Offset Yield Strength and Ultimate Tensile Strength vs. Test Temperature—AerMet 100 Alloy

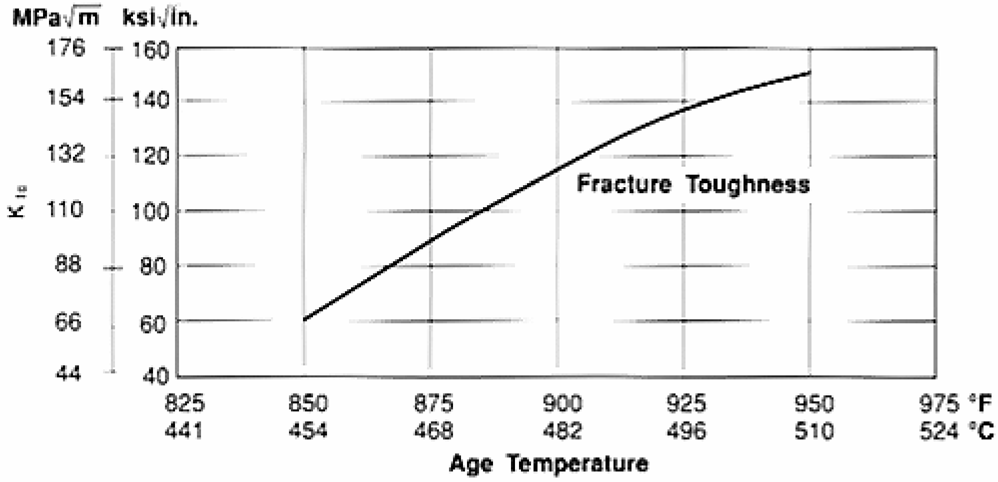
Heat treated 1625°F (885°C) 1 hour, vermiculite cooled, refrigerated -100°F (-73°C) 1 hour, air warmed, aged 900°F (482°C) 5 hours, air cooled.



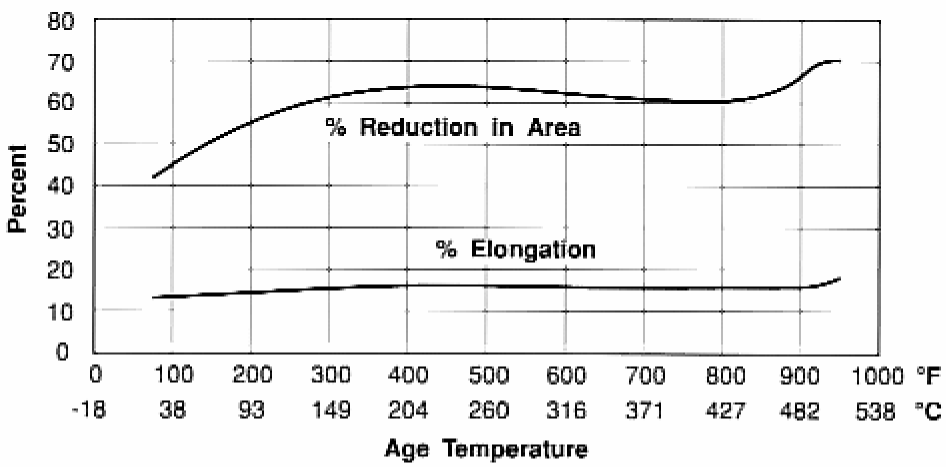
Effect of Aging Temperature on Charpy V-Notch Energy—AerMet 100 Alloy
Longitudinal orientation - Heat treated 1625°F (885°C) 1 hour, air cooled, refrigerated -100°F (-73°C) 1 hour, air warmed, aged 5 hours, air cooled.



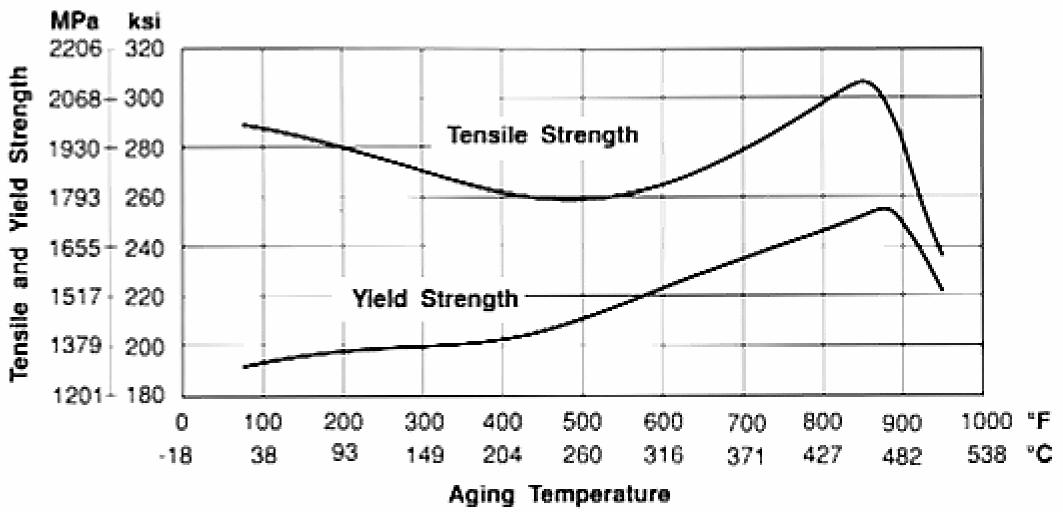
Effect of Aging Temperature on Plane Strain Fracture Toughness—AerMet 100 Alloy
Longitudinal orientation - Heat treated 1625°F (885°C) 1 hour, air cooled, refrigerated -100°F (-73°C) 1 hour, air warmed, aged 5 hours, air cooled.



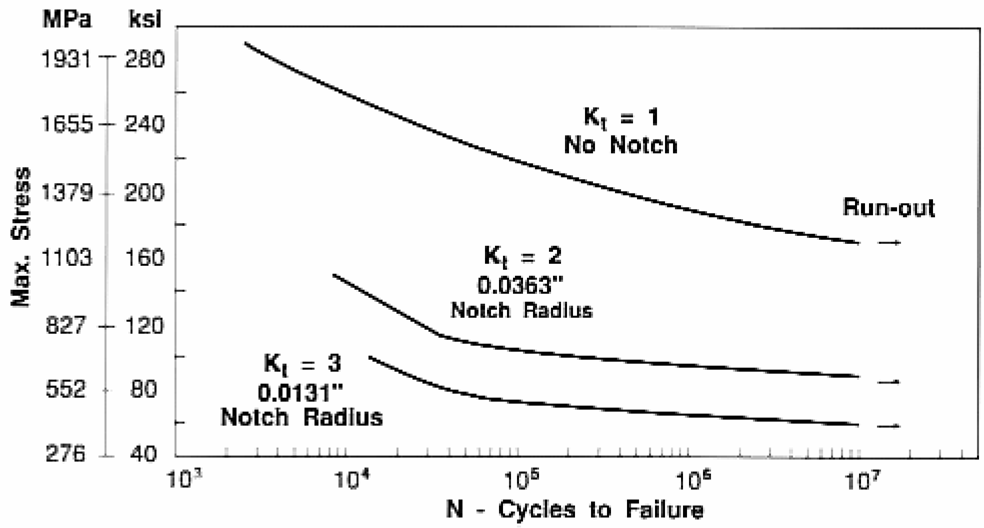
Effect of Aging Temperature on Reduction of Area and Elongation—AerMet 100 Alloy
Longitudinal orientation - Heat treated 1625°F (885°C) 1 hour, air cooled, refrigerated -100°F (-73°C) 1 hour, air warmed, aged 5 hours, air cooled.



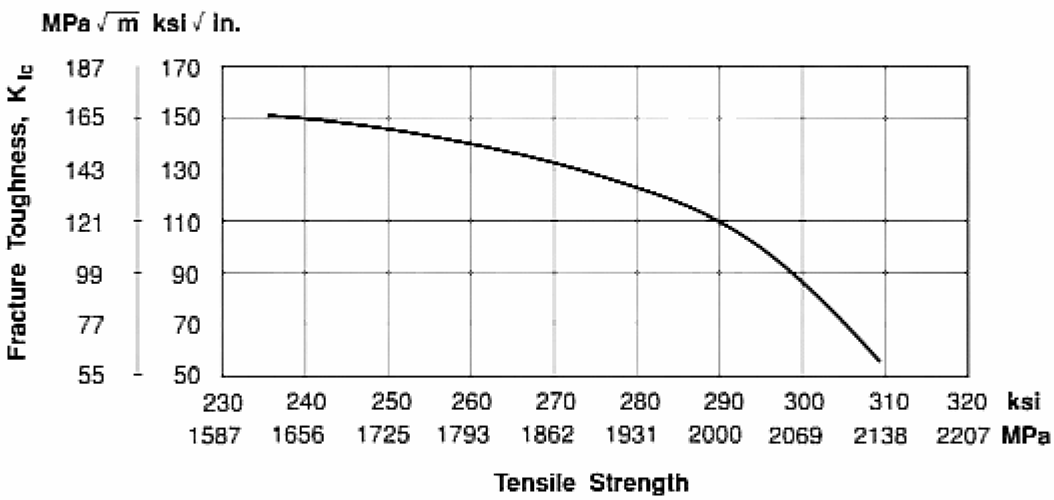
Effect of Aging Temperature on Tensile and Yield Strengths—AerMet 100 Alloy
Longitudinal orientation - Heat treated 1625°F (885°C) 1 hour, air cooled, refrigerated -100°F (-73°C) 1 hour, air warmed, aged 5 hours, air cooled.



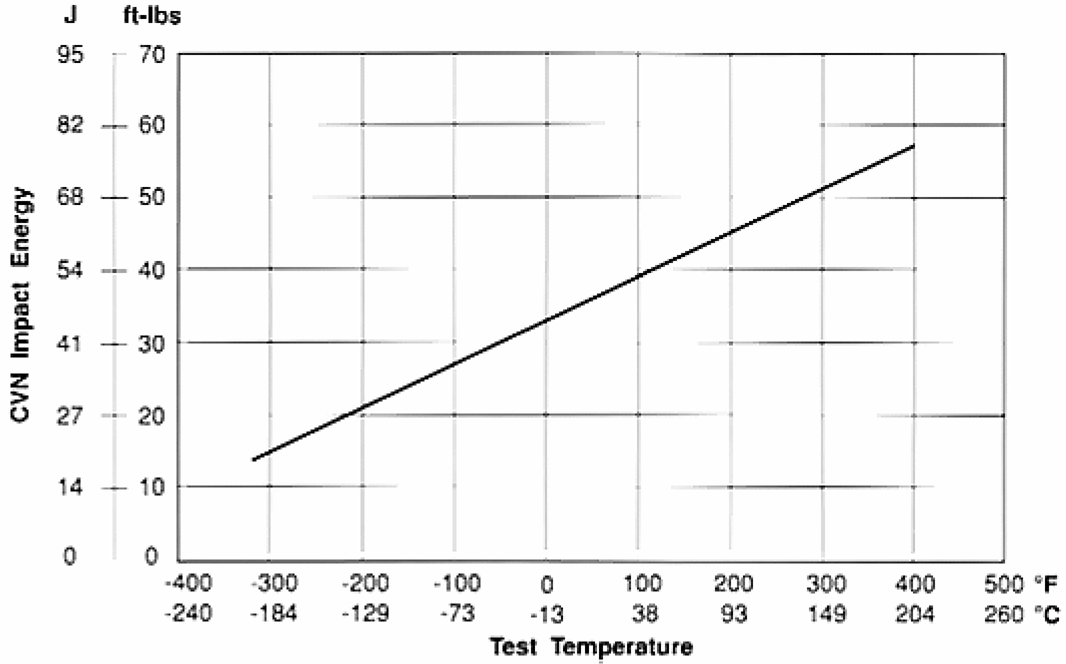
Effect of Specimen Design on Fatigue Resistance—AerMet 100 Alloy
K_t=1 data are from two labs. R=0.



Fracture Toughness vs. Tensile Strengths—AerMet 100 Alloy
Longitudinal data. Solution treated 1625°F (885°C).



Typical Charpy V-Notch Impact Energy—AerMet 100 Alloy
L-R orientation. Heat treatment: 1625°F (885°C) 1 hour, vermiculite cooled, refrigerated -100°F (-73°C) 1 hour, air warmed, aged 900°F (482°C) 5 hours.



Typical Mechanical Properties—AerMet 100 Alloy
Heat treatment - 1625°F (885°C) 1 hour, air cooled, -100°F (-73°C) 1 hour, aged 900°F (482°C) 5 hours.

Yield Strength		Ultimate Tensile Strength		% Elongation	% Reduction of Area	Charpy V-Notch Impact Energy		Fracture Toughness K_{IC}*	
ksi	MPa	ksi	MPa			ft-lbs	J	ksi√in	MPa√M
Longitudinal Orientation									
250	1724	285	1965	14	65	30	41	115	126
Transverse Orientation									
250	1724	285	1965	13	55	25	34	100	110

Heat Treatment

Decarburization

Like other carbon bearing high strength alloys, AerMet 100 alloy is subject to decarburization during hardening. Heat treatment should take place in a neutral atmosphere furnace, salt bath or vacuum. Decarburization should be determined by comparing the surface and internal hardness of a small test cube for proper response. Metallographic determination of decarburization is not recommended for this alloy.

Normalizing

AerMet 100 alloy can be normalized by heating to 1650°F (899°C) holding for one hour and air cooling to room temperature. Optimum softening for machining is obtained by following the 1650°F (899°C) normalize with a 16 hour 1250°F (677°C) overage anneal.

Annealing

AerMet 100 alloy is softened by using a 1250°F (677°C) overage anneal for 16 hours. The optimum annealed hardness of 40 HRC maximum is obtained following this anneal.

Solution Treatment

The solution treatment temperature range is 1625°F +/-25°F (885°C +/-14°C) for 1 hour. The solution treatment temperature must be monitored by a thermocouple attached to the load.

Quenching

Water quenching is not recommended.

Proper quenching practice is essential for AerMet 100 alloy. The alloy should be cooled from the solution treatment temperature to 150°F (66°C) in 1 to 2 hours to develop optimum properties. Individual sections larger than 2" diameter or 1" thick (plate) must be quenched with oil in order to obtain 150°F (66°C) in 1 to 2 hours. Individual sections up to 2" diameter or 1" thick (plate) will air cool to 150°F (66°C) in 1 to 2 hours. The cooling rate of the furnace load must be monitored by a thermocouple attached to the hottest spot in the load to insure that the 2 hour cool to 150° (66°C) is obtained.

Cold Treatment

Following cooling to room temperature, to obtain the full toughness capability AerMet 100 alloy should be cooled to -100°F (-73°C) and held for 1 hour. The parts can then be air warmed.

Straightening

AerMet 100 alloy exhibits minimal size change during heat treatment; however, for some parts, mechanical straightening to compensate for distortion during heat treatment is appropriate.

Prior to straightening, a low temperature stress relief at 350/400°F (177/204°C) for 5 hours following the refrigeration operation will provide an optimal combination of ductility and yield strength for the mechanical straightening operation.

Age

The standard aging treatment for AerMet 100 alloy is 900°F +/-10°F (482°C +/-6°C) for 5 hours. Parts made from AerMet 100 alloy should never be aged at a temperature below 875°F (468°C).

Effect of Aging Temperature on Hardness—AerMet 100 Alloy
Specimens solution treated using 1625°F (885°C) 1 hour, air cooled, refrigerated -100°F (-73°C) 1 hour.

Aging Temperature	HRC
As hardened	51.0/53.0
875°F (468°C) 5 hrs.	54.5/55.5
900°F (482°C) 5 hrs.	53.0/54.0
925°F (496°C) 5 hrs.	51.0/52.5

Workability

Forging

Primary break down forging of AerMet 100 alloy should be done at a maximum starting temperature of 2250°F (1232°C). Finish forging should be done from 1800°F (982°C) with a finishing temperature below 1650°F (899°C) in order to optimize the final heat treated properties. Following forging the parts should be air cooled to room temperature and then annealed. Following the anneal the forgings should be normalized in order to restore properties to the dead zone.

Machinability

AerMet 100 alloy is somewhat more difficult to machine than 4340 at Rockwell C 38. Carbide tools are recommended at 280 to 350 SFM.

Following rough machining, if a stress relief is desired, stress relieve at 800°F (427°C) for 1 to 3 hours.

Other Information

Applicable Specifications

- AMS 6532
- McDonnell Douglas MMS 217
- MIL HDBK-5

Forms Manufactured

- Bar-Rounds
- Billet
- Hollow Bar
- Plate
- Sheet
- Strip
- Weld Wire
- Wire

Technical Articles

- A Designer's Manual On Specialty Alloys For Critical Automotive Components
- A Guide to Etching Specialty Alloys for Microstructural Evaluation
- Aerospace Alloy Has Been A Huge Success in Golf Club Design
- New Requirements for Ferrous-Base Aerospace Alloys
- Selection of High Strength Stainless Steels for Aerospace, Military and Other Critical Applications
- Toughness Index for Alloy Comparisons
- Trends in High Temperature Alloys

Disclaimer:
The information and data presented herein are typical or average values and are not a guarantee of maximum or minimum values. Applications specifically suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his/her own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes. There is no representation that the recipient of this literature will receive updated editions as they become available.

Edition Date: 09/01/1995