CARPENTER TECHNOLOGY

DATASHEET

AerMet® 310

U.S. Patent Number: 5,866,066

Type analysis

Single figures are nominal except where noted.

Iron	Balance	**Cobalt**	15.0 %	**Nickel**	11.0 %
Chromium	2.40 %	**Molybdenum**	1.40 %	**Carbon**	0.25 %

Forms manufactured

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

Description

AerMet 310 alloy possesses higher hardness and strength than AerMet 100 while exhibiting exceptional ductility and toughness. At a 310 ksi (2137 MPa) ultimate tensile strength, AerMet 310 exhibits toughness values equivalent to alloys 20 ksi (138 MPa) lower in strength. The alloy should be considered a candidate for use in components requiring high strength, high fracture toughness, and exceptional resistance to stress corrosion cracking and fatigue.

Key Properties:

- High strength
- Exceptional ductility
- High fracture toughness
- Corrosion resistance

Markets:

- Aerospace
- Defense
- Industrial
- Transportation

Applications:

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

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Corrosion resistance

AerMet 310 possesses environmental resistance similar to AerMet 100.

Important Note:
The following 4-level rating scale (Excellent, Good, Moderate, Restricted) is intended for comparative purposes only and is derived from experiences with wrought product. Additive manufactured material may perform differently; corrosion testing is recommended. Factors that affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish, and dissimilar metal contact.

Humidity	Restricted

Physical properties

PROPERTY	At or From	English Units	Metric Units
DENSITY	Room temperature	0.289 lb/in^3	8.0 g/cm^3

Typical mechanical properties

EFFECT OF ORIENTATION ON TYPICAL MECHANICAL PROPERTIES[1]

ORIENTATION	YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION	REDUCTION OF AREA	CHARPY V-NOTCH
	ksi	MPa	ksi	MPa	%	%	FT-LBS
Longitudinal	275	1896	315	2172	14.5	63	20
Transverse	275	1896	315	2172	13.0	53	17

[1] Heat treatment: 1675°F +/- 25°F (913°C +/- 14°C) 1 hour, air cooled, -100°F (-73°C) 1 hour, 900°F +/- 10°F (482°C +/- 6°C) 6 hours, air cool

TYPICAL ROOM TEMPERATURE VS. ELEVATED TEMPERATURE, 400°F (204°C), LONGITUDINAL[1]

TEST TEMPERATURE		YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION	REDUCTION OF AREA
°F	°C	ksi	MPa	ksi	MPa	%	%
Room temperature		269	1852	311	2145	15.2	66.4
400	204	252	1737	283	1948	16.0	66.2

[1] Heat treatment: 1675°F (913°C), 1 hour, air cooled, -100°F (-73°C) 1 hour, air warmed, 900°F (482°C) 5 hours, air cool

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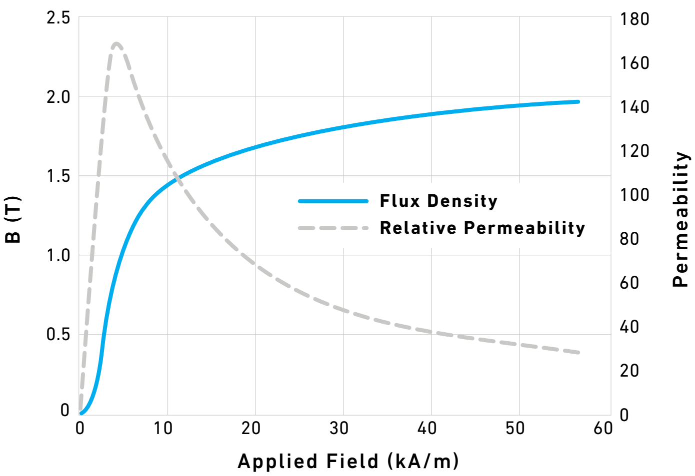
Typical magnetic properties

DC NORMAL MAGNETIC PROPERTIES — 0.0906 IN. THICK STRIP



Heat treatment: 1700°F (926°C) 1 hour, air cooled, -100°F (-73°C) 8 hours, air warmed, 900°F (482°C) 5 hours, air cool

DC PROPERTIES

B_{MAX} (T)	H_{MAX} (kA/m)	B_r (T)	H_c (kA/m)	MAX Perm
1.97	56.57	1.01	3.12	168

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Heat treatment

Decarburization	Like other carbon-bearing high-strength alloys, AerMet 310 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 310 can be normalized by heating to 1775°F (968°C), holding for 1 hour and air cooling to room temperature. Optimum softening for machining is obtained by following the 1775°F (968°C) normalize with a 16-hour 1250°F (677°C) overage anneal.
Annealing	AerMet 310 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 1675°F +/- 25°F (913°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 310. 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 in. diameter or 1 in. 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 in. diameter or 1 in. 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 ensure the 2-hour cool to 150°F (66°C) is obtained.
Cold treatment	Following cooling to room temperature, to obtain the full toughness capability, AerMet 310 should be cooled to -100°F (-73°C) and held for 1 hour. The parts can then be air warmed.
Straightening	AerMet 310 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 310 is 900°F +/- 10°F (482°C +/- 6°C) for 3 to 8 hours. Parts made from AerMet 310 should never be aged at a temperature below 875°F (468°C).

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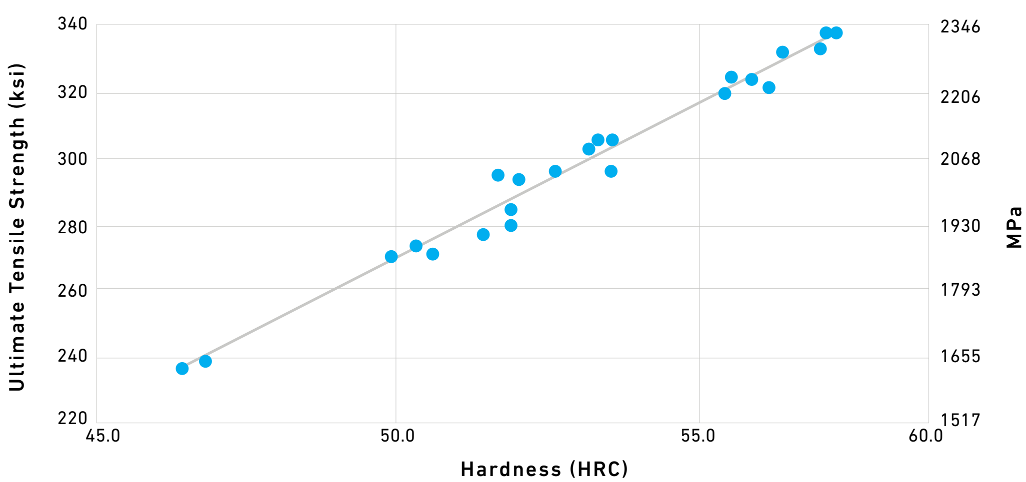
AGING STUDY—UTS VS. HRC



Workability

Forging	Primary breakdown forging of AerMet 310 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 310 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

Technical articles	A Designer's Manual On Specialty Alloys For Critical Automotive Components A Guide to Etching Specialty Alloys for Microstructural Evaluation 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

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