Technical Datasheet CARPENTER TECHNOLOGY

CarTech® No. 158® Alloy

Identification

UNS Number

- T51606

Type Analysis

Single figures are nominal except where noted.

Carbon	0.10 %	**Manganese**	0.50 %
Silicon	0.30 %	**Chromium**	1.50 %
Nickel	3.50 %	**Iron**	Balance

General Information

Description

CarTech No. 158 alloy is a chrome-nickel alloy steel with an analysis representing the best case hardening steel known for parts subject to heavy shock and wear.

This alloy is ideally suited for jobs where an extra measure of core strength is required. Fully treated, CarTech No. 158 alloy attains a core strength of approximately 160 ksi (1103 MPa) tensile strength with a yield point of approximately 135 ksi (931 MPa). These high mechanical properties will be developed in sections up to 5" (127 mm) thick. In addition, case hardened articles possess a higher wear resistant case because of the special alloy content of the steel.

Applications

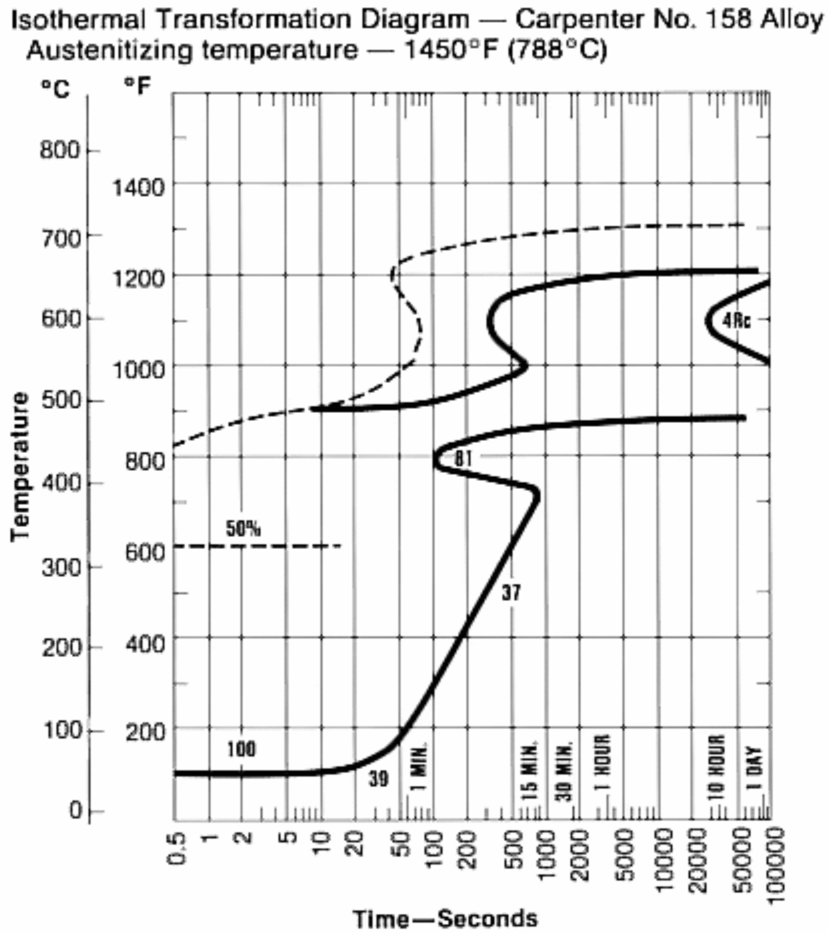
CarTech No. 158® alloy should be considered for use in very large parts requiring maximum strength, wear resistance, and toughness. Typical applications have included heavy-duty gears, shafts, clutch parts, piston pins, chain rollers, chain bushings, wrist pins, boring bars, cutting shanks, jig bars, clutch levers, ratchets, power tool shafts, power tool cams, rock drill assemblies, balls, arbors, broach holders, clutch pins, pneumatic tool parts, and rolls for aluminum rolling machines.

This alloy should also be considered for use in replacement parts for finished assemblies where the load on a particular part has been underestimated or where space or weight limitations prevent redesigning for heavier parts. Breakage at such troublesome spots can frequently be eliminated through the use of CarTech No. 158 alloy.

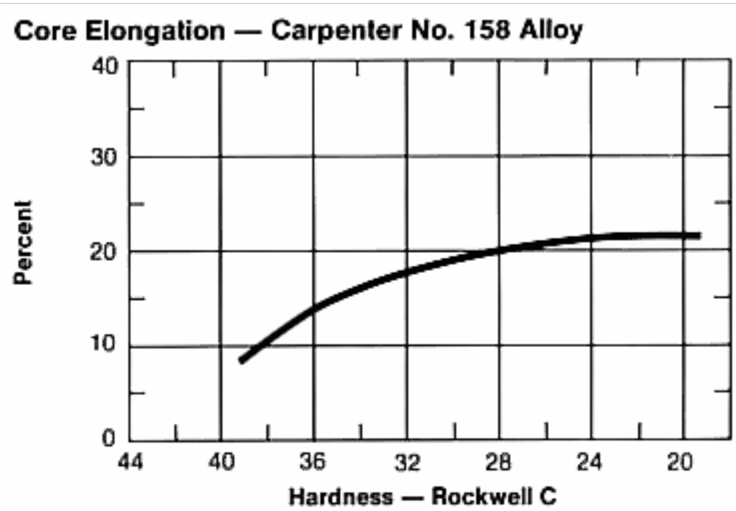
Properties

Physical Properties

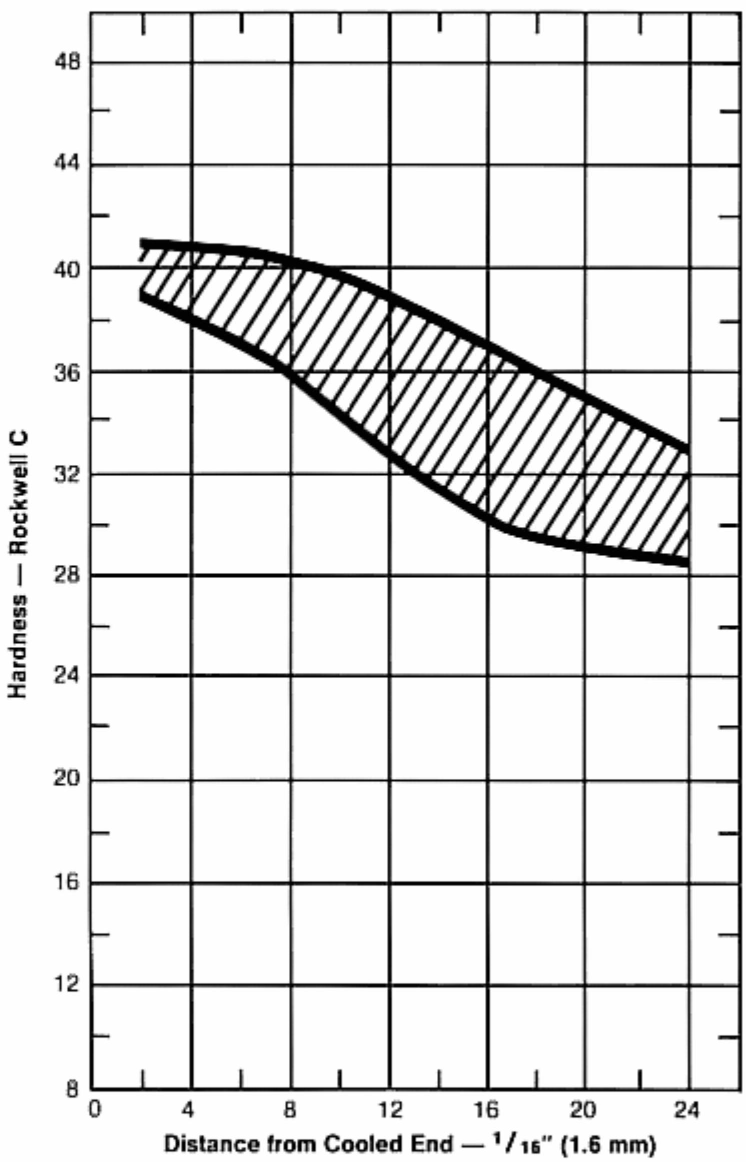
Specific Gravity	7.87	
Density	0.2900	lb/in^3
Mean CTE	6.60	$x 10^{-6}$ in/in/°F
Modulus of Elasticity (E)	30.0	$x 10^{3}$ ksi
Modulus of Rigidity (G)	11.8	$x 10^{3}$ ksi



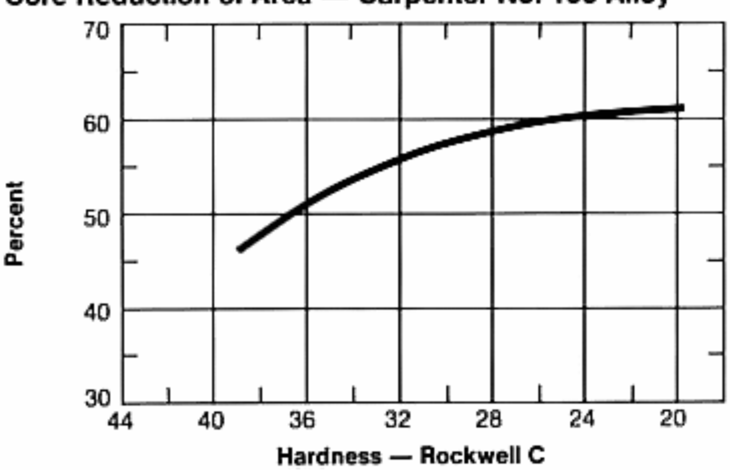
Typical Mechanical Properties



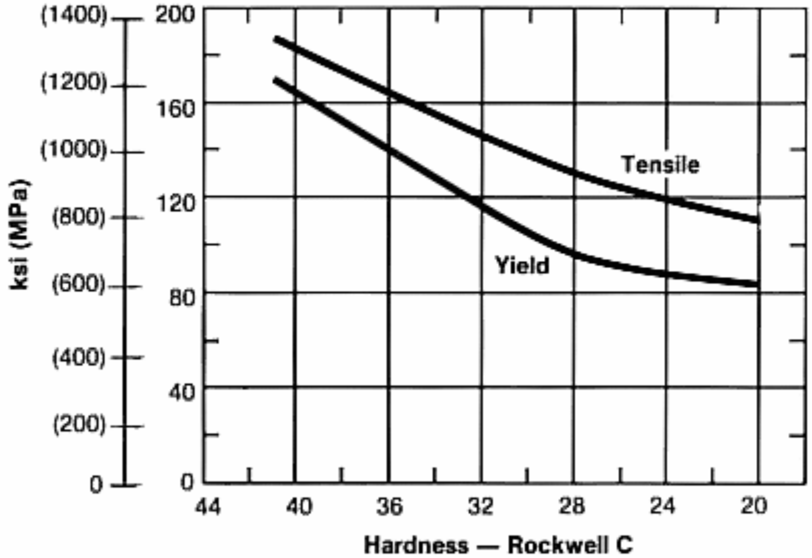
Core Jominy Hardenability — Carpenter No. 158 Alloy



Core Reduction of Area — Carpenter No. 158 Alloy



Core Tensile and Yield Strengths — Carpenter No. 158 Alloy



Typical Case Hardened Mechanical Properties — Carpenter No. 158 Alloy

1" (25.4 mm) round x 6" (152.4 mm) long specimen.
Box: Pipe - 4" (101.6 mm) diameter x 8" (203.2 mm) long.
Time to reach carburizing temperature - 4 hours.
Soak at carburizing temperature - 8 hours.
Carburizing compound used - No. 200 Pearlite - half old and half new.
Heat Treatment - The letters A, B, and C refer to the three different carburizing treatments described in the heat treatment instructions.
Final Temper - In all instances - 1 hour at 300°F (149°C).

Property	Treatment A	Treatment B	Treatment C
Case depth (Observed on fracture)	.078" (2.0 mm)	.078" (2.0 mm)	.0625" (1.6 mm)
Case hardness			
Rockwell C	62	61	61
Shore	85	83	80
Core hardness			
Rockwell C	37	37	38
Shore	42	42	44
Brinell	352	352	363
Physical Properties of Core			
Tensile—ksi	165	165	170
MPa	1,138	1,138	1,172
Yield—ksi	135	135	140
MPa	931	931	965
Elongation in 2" (50.8 mm)	17	16	14
Reduction of Area - %	56	53	48
Grain refinement			
Case	Silky	Silky	Slightly Coarse
Core	Fibrous	Fibrous	Fibrous
Relative toughness of Case and Core combined*	26 ft-lb (35.3 J)	24 ft-lb (32.5 J)	22 ft-lb (29.8 J)

*Unnotched specimens of 10 mm square, carburized, heat treated, and broken on Izod impact machine.

Heat Treatment

Treatment A -
Carburize at 1600/1650°F (871/899°C), pack cool or air cool. For hardening, heat the parts to 1500°F (816°C), quench in oil. Reheat parts to 1425°F (774°C), quench in oil. Temper at 200/300°F (93/149°C). This will produce parts showing the best combination of case properties and core strength; however, the multiple heat treatment will subject the parts to greater distortion and size change.

Treatment B -
To secure less distortion in hardening, the following alternate treatment may be used. Carburize at 1550/1600°F (843/871°C), air cool or pack cool. Heat the parts at 1450°F (778°C), quench in oil. Temper at 200/300°F (93/149°C).

Treatment C -
For highest core properties with some sacrifice of case properties, parts may be carburized at 1550/1600°F (843/ 871°C) and quenched directly in oil. This should be followed by tempering at 200/300°F (93/149°C).

Decarburization

Carpenter No. 158 alloy must first be carburized as described under the heat treatment section of this data sheet to produce a carbon-rich case prior to hardening.

Although Carpenter No. 158 alloy is no more subject to decarburization during heat treatment than any other oil hardening tool steel, decarburization can occur during the hardening operation.

It is suggested that pieces be treated from a controlled atmosphere furnace or from a neutral salt bath.

Normalizing

Heat to 1650/1750°F (899/954°C), cool in air.

Annealing

Heat to 1250/1280°F (677/693°C), then cool slowly. This will produce a maximum Brinell hardness of 229. To secure maximum softness, do not exceed 1280°F (693°C).

Carburizing

Cyanide Treatment -
On molds within sections or projections, carburizing may present a hazard and a short-time cyanide treatment may be found desirable. This operation is performed in a cyanide salt bath at approximately 1450°F (788°C).

The mold may be left in the cyanide bath for a sufficient time to produce the desired case, followed by oil quenching directly from the cyanide pot. This will provide a superficial case of sufficient depth for good wear resistance and a tough core to prevent breakage.

Pack and Gas Carburizing -
Carburize between 1500/1600°F (816/871°C) for long enough to secure the desired case depth. Eight hours at 1600°F (871°C) will produce a case depth of between 0.030 and 0.040" (0.76 and 1.02 mm).

Higher carburizing temperatures up to 1650°F (899°C) may be used if followed by a double hardening operation as described under Treatment A in the "Heat Treatment" section.

During carburizing, it is generally desirable to produce a surface carbon content between 0.80% and 1%. This accounts for the relatively low carburizing temperature. During gas carburizing, the carbon potential of the atmosphere should be maintained to produce the above-mentioned desired carbon levels.

Hardening

Harden from a temperature of 1425/1500°F (774/816°C) followed by oil quenching. Small sections may be fully hardened by air quenching.

It is often desirable to cold treat Carpenter No. 158 alloy after hardening. This is performed by lowering the temperature to under -100°F (-73°C) and holding for one hour, followed by allowing the steel to come back naturally to room temperature.

Deformation (Size Change) in Hardening

While Carpenter No. 158 alloy is subject to distortion during heat treatment, as are all carburizing grades, its deep hardening characteristics render it the most stable of the lot. It will exhibit growth of approximately 0.001 of an inch per inch after carburizing, hardening, and tempering.

Cold Treatment

It is often desirable to cold treat Carpenter No. 158 alloy after hardening. This is performed by lowering the temperature to under -100°F (-73°C) and hold for one hour, followed by allowing the steel to come back naturally to room temperature.

Stress Relieving

Stress relieving to remove machining stresses should be carried out by heating to 1100°F (593°C), holding for one hour at heat, followed by air cooling. This operation is performed to reduce distortion during heat treatment.

Tempering

Effect on Case Hardness -

Actual as-quenched case hardness will vary depending upon the actual heat treating cycle followed. The slope of the tempering curve, however, will remain constant. The hyperlink entitled "Effect of Tempering Temperature on Case Hardness" illustrates tempering effects on case hardness.

Effect on Core or Uncarburized Samples -

The effect of tempering on core or uncarburized samples is illustrated in the hyperlink chart titled "Effect of Tempering Temperature on Core or Uncarburized Samples."

Effect of Tempering Temperature on Case Hardness — Carpenter No. 158 Alloy
Carburized at 1600°F (871°C) 8 hours at heat, air cooled, hardened at 1450°F (788°C), oil quenched, cold treated at -120°F (-84°C).

Tempering Temperature		Rockwell C Hardness
°F	°C	
As Quenched		64/65
300	149	63
350	177	61/62
400	204	61
450	232	60
500	260	59/60
550	288	58/59

Effect of Tempering Temperature on Core or Uncarburized Samples — Carpenter No. 158 Alloy
Core samples oil quenched from 1450/1600°F (788/871°C)

Tempering Temperature		Rockwell C Hardness
°F	°C	
As Quenched		39/41
400	204	39/41
500	260	39
600	316	37
800	427	35
900	482	32
1000	538	27
1100	593	21
1200	649	18

Workability

Forging

Forge from a temperature not over 2100°F (1149°C). Small forging can be cooled in a dry place. Large forgings should be cooled slowly in a furnace.

Machinability

Hot finished annealed Carpenter No. 158 alloy can be machined at about 40% of AISI B1112 steel. Cold drawn bars will machine somewhat faster and cleaner and are better suited for use in automatics.

High-speed steel tools are used for most machining operations while carbide tools are used for high-speed turning, boring, and milling.

Single-point lathe tools work best when using 10-20° rake and plenty of clearance. The large rake reduces the cutting pressure and permits a better surface finish. Surface speeds of 120-180 sfm (0.61-0.91 m/s) are used on moderate cuts with high-speed tools and a good sulfurized cutting fluid.

Form cutters generally have a chip breaker and operate at 80-130 sfm (0.41-0.66 m/s) cutting speeds with feeds of 0.001-0.002" (0.025-0.051 mm).

Drilling is performed with high-speed steel drills of standard design at cutting speeds of 70-90 sfm (0.36-0 46.m/s) on 0.500" (12.7 mm) drills.

Reaming is done at the same speed as drilling, although the speed may be slightly higher.

Milling with high-speed steel cutters can be done at 90-130 sfm (0.46-0.66 m/s) for face milling and 60-90 sfm (0.31-0.46 m/s) for straddle or slot milling.

Precision boring using carbide tip tools can be run without cutting fluid at speeds of 200-400 sfm (1.02-2.03 m/s) to obtain accurate dimensions without overheating.

Rough and finish turning can be done with carbide tip tools at speeds of 200-600 sfm (1.02-3.05 m/s).

It is often necessary to machine Carpenter No. 158 alloy after carburizing. In this case, the annealing procedure described under the "Heat Treatment" section of this data sheet applies. The machinability of the carburized case will be reduced because of the high carbon in this area. Lower speeds and lighter feeds will generally be required.

Other Information

Applicable Specifications

• AMS 6265	• ASTM A646
• QQ-S-624C	• SAE J1249

Forms Manufactured

• Bar-Rounds	• Billet

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