CarTech® No. 882

Identification

UNS Number
- T20811

AISI Number
- Type H-11

Type Analysis

Single figures are nominal except where noted.

Carbon	0.40 %	**Manganese**	0.35 %
Silicon	0.90 %	**Chromium**	5.00 %
Molybdenum	1.35 %	**Vanadium**	0.45 %
Iron	Balance		

General Information

Description

CarTech No. 882 is a 5% chromium hot work tool steel designed particularly for applications requiring extreme toughness combined with good red hardness. It provides an extra margin of safest in tools subject to heavy hammer blows, and those tools containing deep recesses or sharp corners.

While CarTech No. 882 has been designed primarily as a hot work tool steel, it has been used in many cold work applications where extra toughness is required at the sacrifice of some wear resistance.

This alloy has been used at very high strength levels in excess of 260,000 psi (1793 MPa). It also displays high creep and rupture strength at temperatures between 800 and 1200°F (427 and 649°C).

Applications

CarTech No. 882 has been used primarily for tools requiring resistance to softening at elevated temperatures. Such tools include forging dies and punches, die-casting dies, aluminum extrusion dies, hot heading dies, piercing and forming punches, etc.

This tool steel has also found applications in cold work tools where extreme toughness is required due to its high toughness and high compressive strength. Such tools include bulldozer dies, dies with deep recesses and sharp corners, and vanstoning dies, etc.

In addition to a wide variety of hot and cold work applications, CarTech No. 882 has also been used as a structural material for critical components in aircraft and missiles.

Properties

Physical Properties

Specific Gravity	7.77	
Density	0.2800	lb/in³
Mean CTE		
80 to 200°F	6.10	$\times 10^{-6}$ in/in/°F
80 to 400°F	6.40	$\times 10^{-6}$ in/in/°F
80 to 800°F	6.80	$\times 10^{-6}$ in/in/°F
80 to 1000°F	6.90	$\times 10^{-6}$ in/in/°F
80 to 1200°F	7.30	$\times 10^{-6}$ in/in/°F
80 to 1450°F	7.50	$\times 10^{-6}$ in/in/°F
500 to 1200°F	7.80	$\times 10^{-6}$ in/in/°F
500 to 1450°F	8.00	$\times 10^{-6}$ in/in/°F
800 to 1200°F	8.10	$\times 10^{-6}$ in/in/°F
800 to 1450°F	8.20	$\times 10^{-6}$ in/in/°F

Thermal coefficient of expansion

Temperature Range		Coefficient	
°F	°C	10^{-6}/°F	10^{-6}/°C
80- 200	27- 93	6.1	11.0
80- 400	27-204	6.4	11.5
80- 800	27-427	6.8	12.2
80-1000	27-538	6.9	12.4
80-1200	27-649	7.3	13.1
80-1450	27-788	7.5	13.5
500-1200	260-649	7.8	14.0
500-1450	260-788	8.0	14.4
800-1200	427-649	8.1	14.6
800-1450	427-788	8.2	14.8

Thermal Conductivity		
420°F	198.0	BTU-in/hr/ft²/°F
660°F	197.0	BTU-in/hr/ft²/°F
890°F	196.0	BTU-in/hr/ft²/°F
1120°F	199.0	BTU-in/hr/ft²/°F

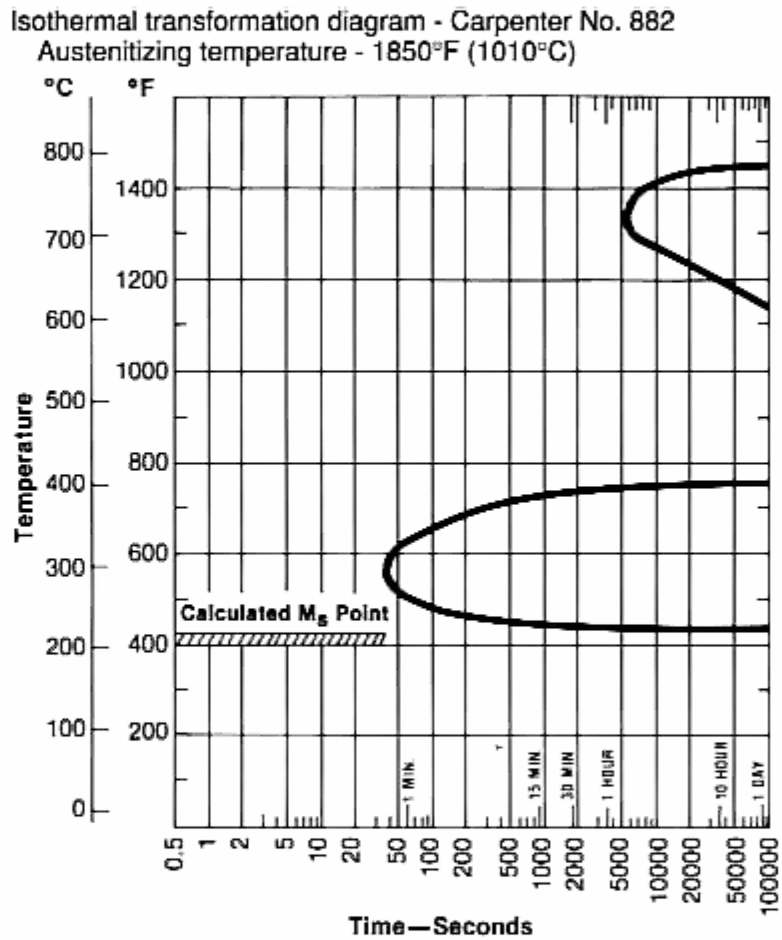
Thermal conductivity

Temperature		Conductivity	
°F	°C	Btu-in/ft² • hr • °F	W/m • K
420	216	198	28.6
660	349	197	28.4
890	477	196	28.3
1120	604	199	28.7

Modulus of Elasticity (E)		
70°F	30.5	x 10^3 ksi
300°F	27.8	x 10^3 ksi
500°F	26.1	x 10^3 ksi
650°F	27.7	x 10^3 ksi
800°F	27.3	x 10^3 ksi
900°F	27.0	x 10^3 ksi
1000°F	22.7	x 10^3 ksi
1100°F	21.0	x 10^3 ksi
1200°F	16.5	x 10^3 ksi

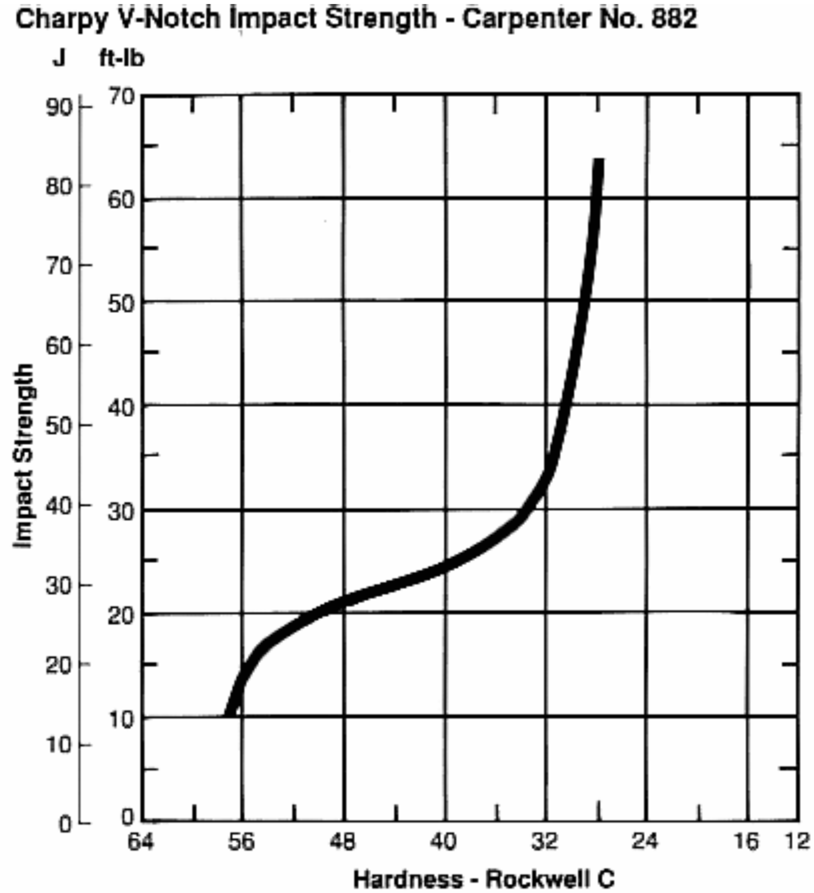
Modulus of elasticity

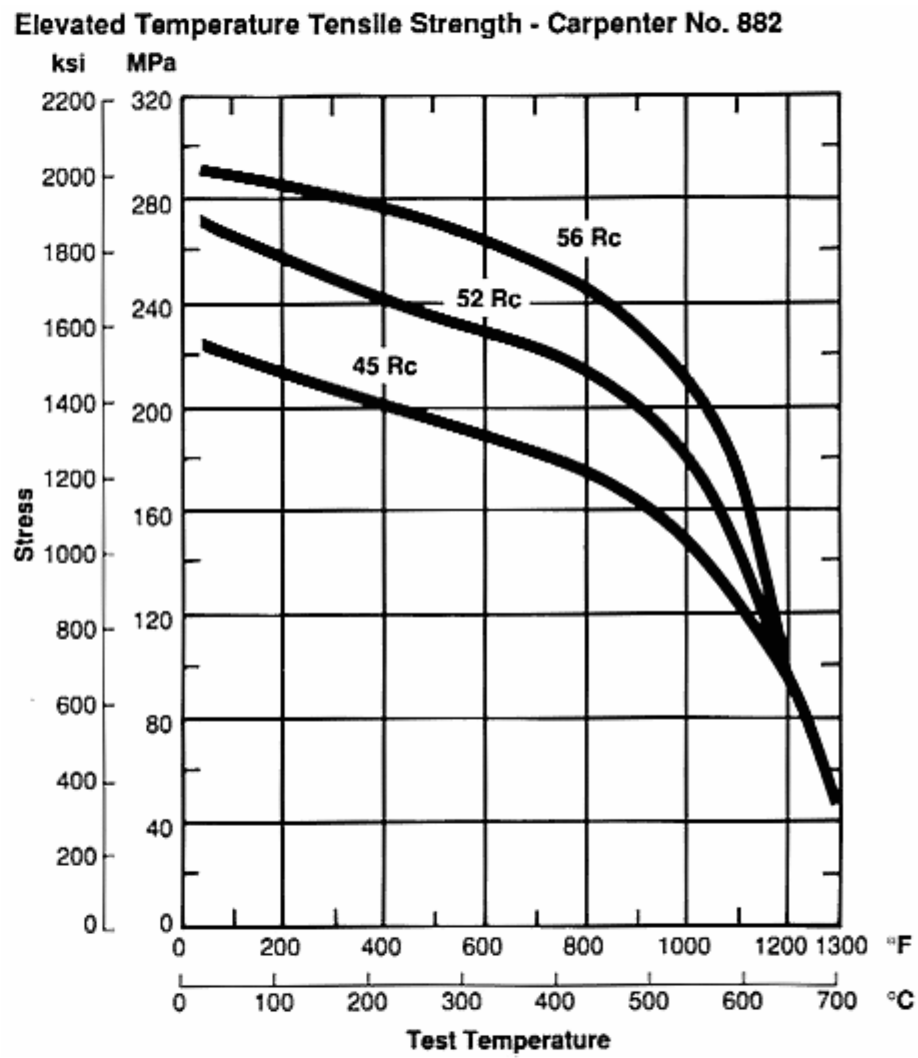
Temperature		Modulus	
°F	°C	ksi	MPa
70	21	30.5	210
300	149	27.8	191
500	260	26.1	179
650	343	27.7	190
800	427	27.3	188
900	482	27.0	186
1000	538	22.7	157
1100	593	21.0	145
1200	649	16.5	114



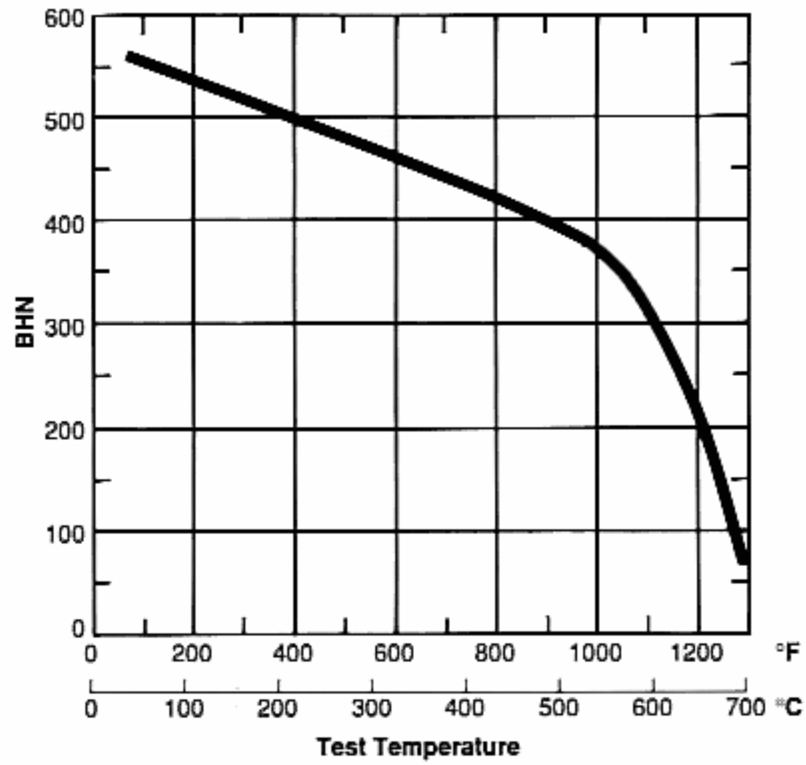
Critical Temperature (AC1)	1505 °F

Typical Mechanical Properties

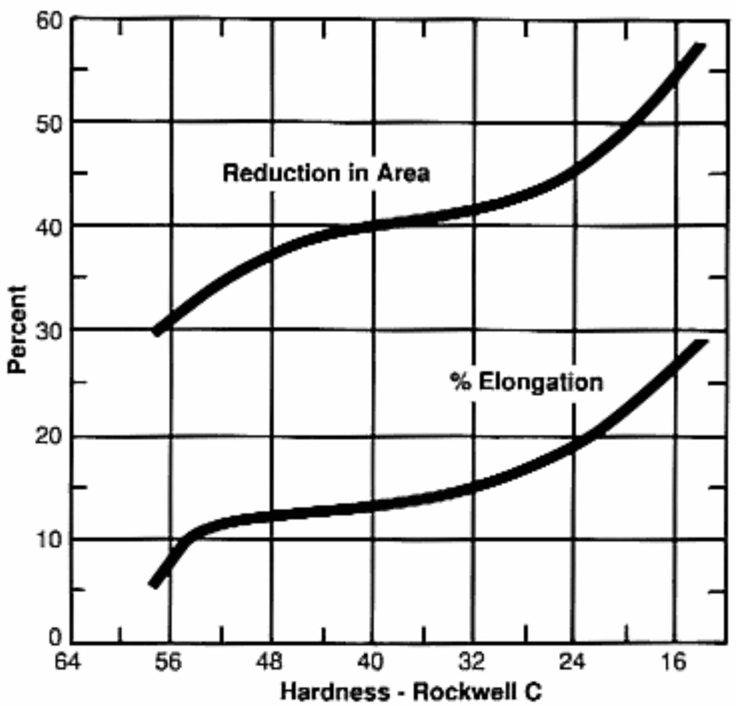


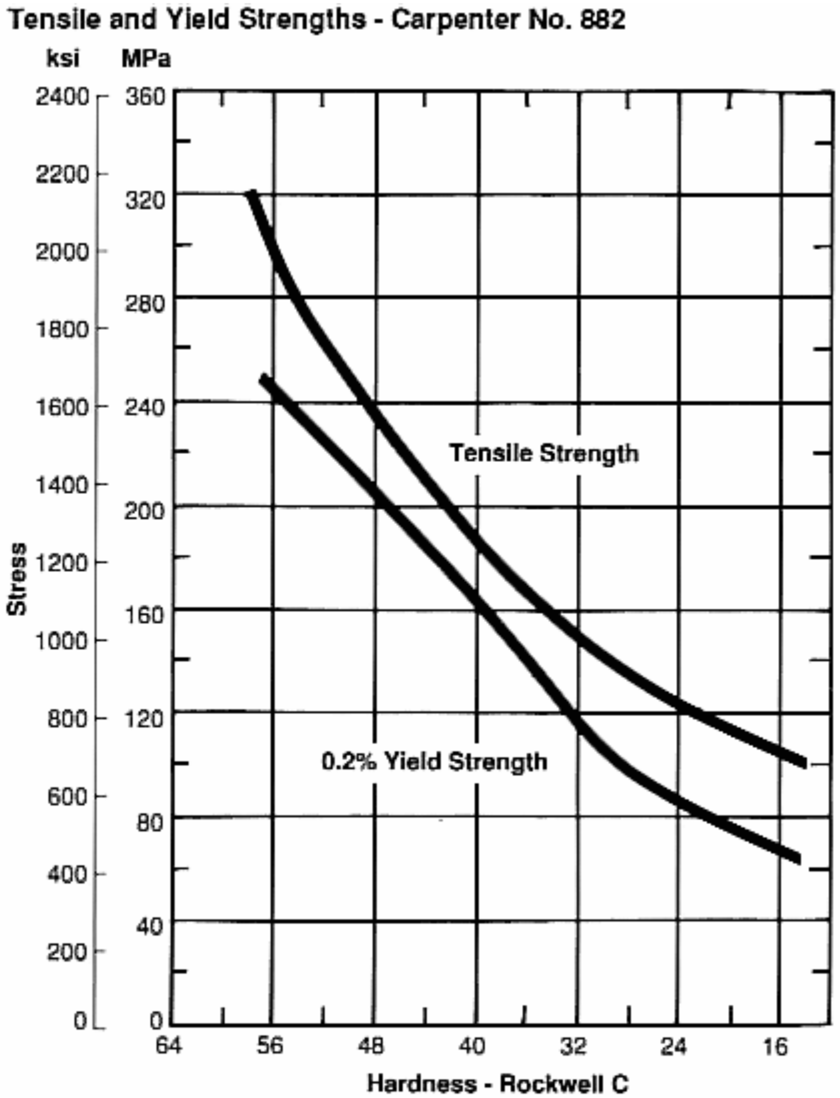

Elevated Temperature Tensile Strength - Carpenter No. 882
ksi
MPa
Stress
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
320
280
240
200
160
120
80
40
0
56 Rc
52 Rc
45 Rc
0
200
400
600
800
1000
1200
1300
°F
0
100
200
300
400
500
600
700
°C
Test Temperature

Hot Brinell Hardness - Carpenter No. 882



Reduction in Area and % Elongation - Carpenter No. 882





Heat Treatment

Decarburization

No. 882 can be hardened without danger of decarburization in controlled atmosphere furnaces using a dew point between 40 and 55°F (4 and 13°C), or from properly rectified neutral salt baths. If not treated in a controlled atmosphere furnace or a salt bath, the steel should be packed in neutral packing compound for hardening.

Normalizing

Normalizing is generally not necessary for this grade; however, in cases where optimum properties are essential, forgings may be heated to 1950°F (106°C), soaked for one hour per inch of thickness, air cooled, and immediately annealed after the forging has cooled to room temperature. It should be noted that there is some danger of cracking following this procedure; however, it does produce the optimum structure and hence, optimum properties.

Annealing

For annealing, the steel should either be packed in a suitable container, using a neutral packing compound, or placed in a controlled atmosphere furnace. Heat uniformly to 1550/1600°F (843/871°C) and cool very slowly in the furnace at a rate of not more than 20°F (11°C) per hour until the furnace is black. The furnace may then be turned off and allowed to cool naturally. This will produce a maximum hardness of Brinell 241.

To relieve machining strains for greater accuracy in hardening, first rough machine, then anneal below the critical 1200/1250°F (649/677°C) a minimum of one hour at temperature, and cool very slowly, followed by finish machining.

Hardening

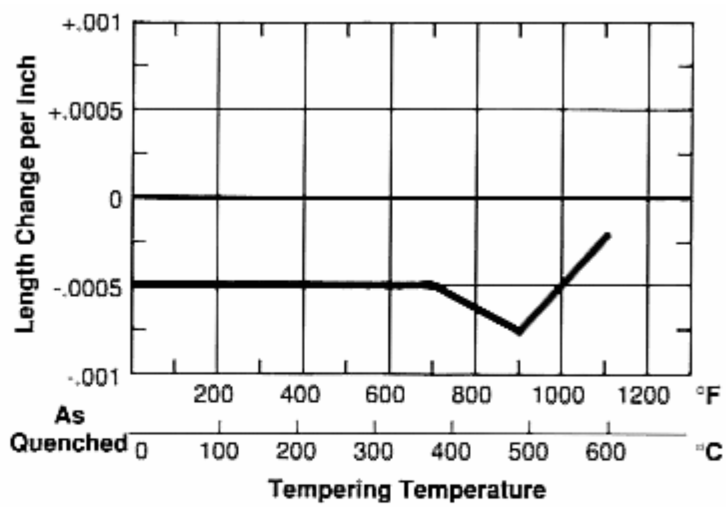
No. 882 may be air treated or oil treated. For air treating, heat the furnace to 1850/1875°F (1010/1024°C), then place the tool right in the hot furnace near the thermocouple. Endothermic atmospheres should be held to a dew point limit of between +40/55°F (+4/13°C).

Let the tool heat naturally until it uniformly matches the color of the thermocouple. Soak 20 minutes plus an additional 5 minutes per inch of thickness and air cool. Neutral salt baths may also be used for heat treatment.

When oil treating No. 882, follow the same procedures as described above, but drop the temperature to 1825/1850°F (996/1010°C).

Deformation (Size Change) in Hardening

Because No. 882 will harden in either oil or air, it holds size and shape extremely well. Some slight shrinkage on hardening can be expected. The diagram below depicts the results obtained on a 1" (25.4 mm) diameter specimen 5" (127 mm) long austenitized at 1875°F (1024°C), oil quenched.



Tempering

The effect of tempering temperature in the hardening of No. 882 is shown in the following chart. Double and even triple tempering is suggested to produce optimum mechanical properties, particularly those associated with ductility.

Effect of Tempering Temperature on Hardness - Carpenter No. 882
Austenitize 1825/1875°F (996/1024°C)
Quench: Oil or air

Tempering Temperature		Rockwell C Hardness
°F	°C	
As quenched		56/57
300	149	55/56
400	204	55/56
500	260	55/56
600	316	54/55
700	371	54/55
800	427	54/55
900	482	55/56
1000	538	56/57
1100	593	45/50
1200	649	33/38
1300	704	25/30

Workability

Forging

Heat slowly and uniformly to a temperature of between 2000/2075°F (1093/1135°C) and forge. Do not work the steel below 1700°F (927°C). Reheat as often as necessary.

Small simple forgings may be cooled slowly in lime. The best practice for large forgings is to place them in a heated furnace at about 1450°F (788°C), soak uniformly at this temperature, then shut off the heat and cool. This is not an anneal, and when the forging is cooled, it must be annealed.

Machinability

The machinability of No. 882 may be rated between 55% and 65% of a 1% carbon water hardening tool steel, or about 40% to 50% of B1112. Approximate turning speeds of 75/90 surface feet per minute (0.38/0.46 m/s) are suggested when using high speed cutting tools.

Following are typical feeds and speeds for No. 882.

Turning—Single Point and Box Tools

Depth of Cut In.	High Speed Tools			Carbide Tools			
	Speed, fpm	Feed, ipr	Tool Material	Speed, fpm		Feed, ipr	Tool Material
				Brazed	Throw Away		
.150	75	.015	M-42	300	375	.015	C-6
.025	90	.007	M-42	375	425	.007	C-7

Turning—Cut-Off and Form Tools

Speed, fpm	Feed, Inches per Rev.							Tool Material
	Cut-Off Tool Width, Inches			Form Tool Width, Inches				
	1/16	1/8	1/4	1/2	1	1-1/2	2	
65	.001	.0015	.002	.0015	.001	.001	.0007	M-2
195	.003	.0045	.006	.003	.0025	.0025	.0015	C-6

Drilling

Speed, fpm	Feed, Inches per Rev.								Tool Material
	Nominal Hole Diameter, Inches								
	1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
50	.001	.002	.003	.006	.008	.010	.011	.013	M-1; M-10

Reaming

High-Speed Tools								Carbide Tools	
Speed, fpm	Feed, Inches per Rev.						Tool Material	Speed, fpm	Tool Material
	Reamer Diameter, Inches								
	1/8	1/4	1/2	1	1-1/2	2			
55	.003	.005	.008	.012	.015	.018	M-7	175	C-2

Milling—End Peripheral

Depth of Cut In.	High Speed Tools						Carbide Tools					
	Speed, fpm	Feed—Inches per Tooth				Tool Material	Speed, fpm	Feed—Inches per Tooth				Tool Material
		Cutter Diameter, Inches						Cutter Diameter, Inches				
		1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
.050	80	.001	.002	.003	.004	M-2; M-7	300	.0015	.0025	.004	.005	C-6

Broaching

Speed, fpm	Chip Load, Inches per Tooth	Tool Material
20	.003	M-2; M-7

Sawing—Power Hack Saw

Pitch—Teeth per Inch				Speed	Feed
Material Thickness, Inches					
Under 1/4	1/4-3/4	3/4-2	Over 2	Strokes/Minute	Inches/Stroke
10	6	6	4	140	.006
10	6	6	4	70	.003
10	10	6	4	85	.003

Additional Machinability Notes

Figures used for all metal removal operations covered are average. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds and feeds should be increased or decreased in small steps.

Weldability

To salvage tools and dies by welding, preheat to 1000°F (538°C) in a furnace and weld with uncoated arc equipment (atomic hydrogen or heliarc). Keep the temperature of the die above 600°F (316°C) at all times by reheating until the welding is completed. Upon completion of the weld, return the work piece to the preheating furnace, equalize, and cool in the furnace. Welding should be performed in the annealed condition. However, if welding is performed in the hardened condition, the tool should be retempered at 1000°F (538°C) after hardening. The electrode material used in the weld rod should be of similar analysis to the base material.

Other Information

Applicable Specifications

- ASTM A681

Forms Manufactured

- Bar-Flats
- Bar-Rounds
- Bar-Squares
- Wire-Shapes

Edition Date: 02/01/1990