Technical Datasheet

CarTech® D3 Tool Steel

Identification

UNS Number
- T30403

AISI Number
- Type D3

Type Analysis

Single figures are nominal except where noted.

Carbon	2.10 %	**Manganese**	0.35 %
Silicon	0.30 %	**Chromium**	12.00 %
Nickel	0.50 %	**Iron**	Balance

General Information

Description

CarTech D3 tool steel is an oil hardening, high-chromium tool and die steel possessing extreme wear resistance. It hardens with very little change in size or shape. CarTech D3 tool steel is deep hardening and exhibits very high compressive strength. Because of its high percentage of chromium, it displays mild corrosion resisting properties when hardened.

Applications

CarTech D3 tool steel has been used for tools requiring a combination of hardening accuracy and safety with maximum wear resistance and greatest possible production.

1. Use it for tools requiring exceptionally long life or for work on abrasive materials such as:

Spindles
Hobs
Cold rolls
Slitting cutters
Master tools
Blanking dies
Forming dies
Lamination dies

2. Use it for tools that must hold size and shape more accurately than water hardening steels or where the shape makes water quenching dangerous such as:

Thread gauges
Spinning tools
Extrusion dies
Intricate punches
Blanking dies
Trimming dies
Plungers

Properties

Physical Properties

Specific Gravity	7.86	
Density	0.2840	lb/in³

Mean CTE	
68 to 212°F	5.93 x 10^{-6} in/in/°F
68 to 392°F	6.45 x 10^{-6} in/in/°F
68 to 572°F	6.73 x 10^{-6} in/in/°F
68 to 752°F	6.89 x 10^{-6} in/in/°F
68 to 932°F	7.09 x 10^{-6} in/in/°F
68 to 1112°F	7.14 x 10^{-6} in/in/°F
68 to 1292°F	7.21 x 10^{-6} in/in/°F
68 to 1382°F	7.26 x 10^{-6} in/in/°F

Mean coefficient of thermal expansion

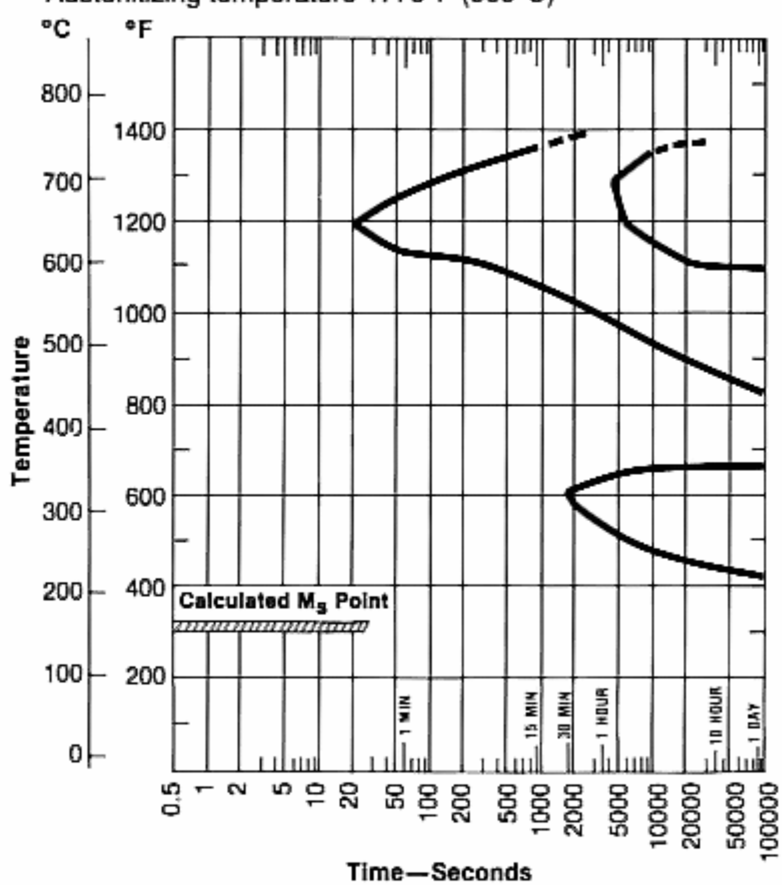
The following figures are the average coefficients between room temperature and the specified elevated temperature. They represent material in the annealed condition and the dimensions are in in/in/° temperature.

Temperature		10^{-6}/°F	10^{-6}/°C
68°F to	20°C to		
212	100	5.93	10.7
392	200	6.45	11.6
572	300	6.73	12.1
752	400	6.89	12.4
932	500	7.09	12.8
1112	600	7.14	12.9
1292	700	7.21	13.0
1382	750	7.26	13.1

Modulus of Elasticity (E) 30.0 x 10^{3} ksi

Isothermal transformation diagram - Hampden Tool Steel

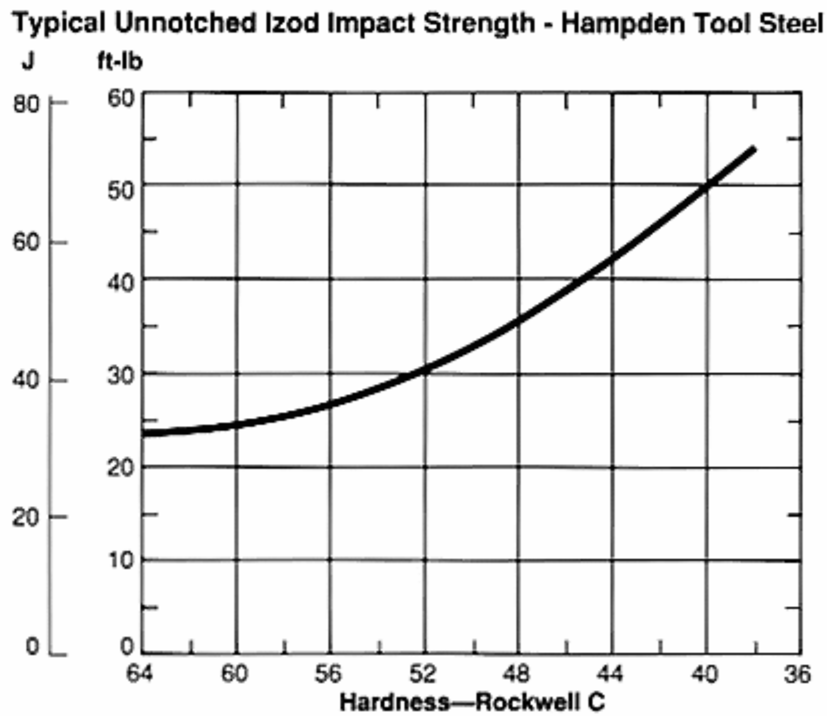
Austenitizing temperature 1775°F (969°C)



Typical Mechanical Properties

High-carbon, high-chromium steels such as Hampden tool steel achieve their excellent wear resistance because of a chemical balance which renders them notch sensitive and low in ductility.

Meaningful tensile data are unavailable, but practical experience indicates that compressive load in excess of 400 ksi (2758 MPa) can be withstood if evenly applied at low rates of loading.



Heat Treatment

Decarburization

Hampden tool steel, like all high carbon tools steels, is subject to decarburization during thermal processing and precautions must be taken to control this condition. Modern furnaces are available which provide environments designed to minimize decarburization.

Normalizing

Normalizing is not recommended and is not necessary after furnace cooling as described in the annealing section.

Annealing

For annealing, Hampden tool 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 255.

Hardening

Hampden tool steel is extremely sensitive to overheating during hardening. It is therefore very important that care be taken to insure that the hardening temperature is within the recommended range of 1750/1800°F (854/982°C).

If overheated, Hampden tool steel, like other high-carbon, high-chrome tool steels, will not obtain its maximum hardness and will shrink badly. Tools should be soaked at temperature 20 minutes plus 5 minutes per inch of thickness.

Without preheating, place the tool right in the hot furnace and let it heat naturally until it uniformly matches the color of the thermocouple in the furnace. First, heat the salt bath or furnace to 1750/1800°F (854/982°C) and soak 20 minutes plus 5 minutes per inch of thickness, then quench in oil.

Control of decarburization can be accomplished by using any one of the several modern heat treating furnaces designed for this purpose. If endothermic atmospheres are used, a dew point between +20/40°F (-6.7/+4.4°C) is suggested.

In older type manually operated exothermic atmosphere furnaces, an oxidizing atmosphere is required. Excess oxygen of about 4 to 6% is preferred.

If no atmosphere is available, the tool should be pack hardened or wrapped in stainless steel foil to protect its surface.

Deformation (Size Change) in Hardening

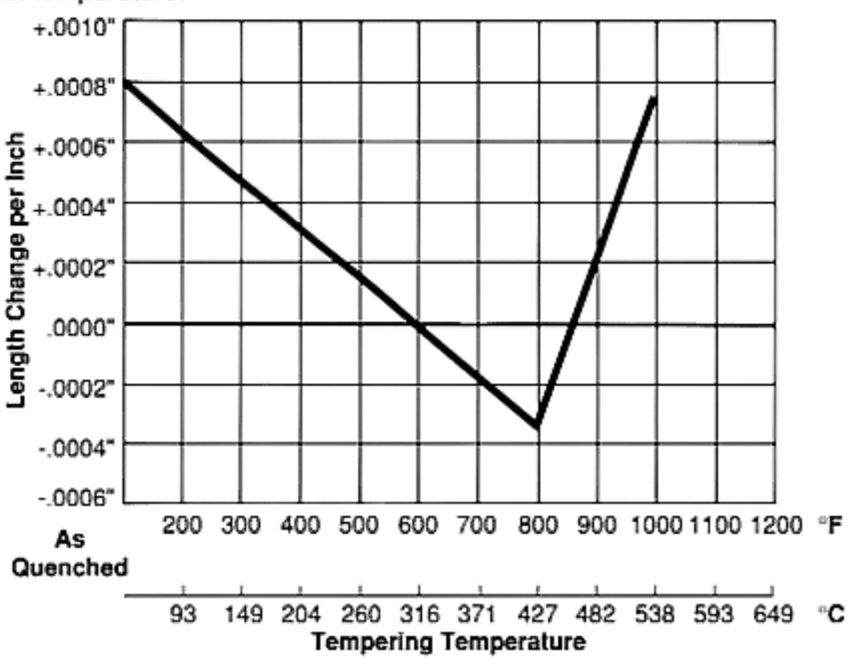
The hyperlink entitled "Size Change in Hardening" illustrates typical length changes of Hampden tool steel when properly hardened. Note that the length change information is presented in inches per inch of original length.

The graph shows that this alloy can be expected to expand when tempered at temperatures up to 600°F (315°C) but shrink when tempered between 600 and 850°F (315 and 454°C). It expands about .0003 inches/inch when tempered at 400°F (204°C) but shrinks about .0003 inches/inch when tempered at 800°F (427°C).

Remember that tool steels hold size best when quenched from the proper hardening temperature. If overheated, they tend to show shrinkage after tempering. Hampden tool steel is particularly sensitive to this problem and therefore should never be hardened from a temperature above 1825°F (996°C). The temperatures used to develop this data are noted on the graph.

Size Change in Hardening - Hampden Tool Steel

1" (25.4 mm) diameter specimens oil quenched from 1775°F (969°C) and tempered 1 hour at temperature.



Stress Relieving

To relieve machining stresses for greater accuracy in hardening - first, rough machine, then heat to a temperature of 1200/1250°F (649/677°C) for a minimum of one hour at temperature and cool slowly - then finish machine.

Tempering

The effect of tempering at various temperatures after oil quenching from 1775°F (969°C) is illustrated in the hyperlink titled "Effect of Tempering Temperature on Hardness."

To secure maximum hardness and wear resistance with fair toughness, temper at 400°F (204°C). Considerably greater ductility with some sacrifice in hardness can be achieved by tempering at 800°F (427°C).

Effect of Tempering Temperature on Hardness - Hampden Tool Steel
Specimens oil quenched from 1775°F (969°C) and tempered at indicated temperature.

Tempering Temperature		Rockwell C Hardness	Equivalent Scleroscope
°F	°C		
As Hardened		65/66	94
200	93	64/66	93
300	149	63/64	90
400	204	62/63	88
600	316	59/60	83
800	427	58/59	82
1000	538	51/53	70
1200	649	37/39	51
1300	704	32/34	44

Workability

Forging

Hampden tool steel forges very much like a high speed steel. Heat slowly and uniformly and forge from a temperature between 1925/2000°F (1052/1093°C).

Do not continue forging below 1700°F (927°C). Reheat as often as necessary. Small, simple forgings can be cooled slowly in lime.

The best practice for large forgings is to place them in a furnace heated to about 1550°F (843°C), soak uniformly at this heat, then shut off the heat and cool the job slowly in the furnace. This is not an anneal. After the forging is cold it must be annealed as indicated in the annealing section.

Machinability

The machinability of Hampden tool steel may be rated between 35 and 40% of Type W-1 tool steel or about 25 to 30% of B1112.

Following are typical feeds and speeds for Hampden tool steel.

Turning—Single Point and Box Tools

Depth of Cut, in.	High-Speed Tools			Carbide			
	Speed, fpm	Feed, ipr	Tool Material	Speed, fpm		Feed, ipr	Tool Material
				Brazed	Throw Away		
.150	45	.010	M-2	160	210	.010	C-6
.025	60	.005	M-3	210	250	.005	C-7

Turning—Cut-Off and Form Tools

Speed, fpm	Feed, ipr							Tool Material
	Cut-Off Tool Width, Inches			Form Tool Width, Inches				
	1/16	1/8	1/4	1/2	1	1-1/2	2	
45	.001	.001	.0015	.0015	.001	.0007	.0007	M-2
145	.002	.002	.003	.0025	.0015	.0015	.0015	C-6

Drilling

Speed, fpm	Feed, ipr								Tool Material
	Nominal Hole Diameter, Inches								
	1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
30	.001	.001	.003	.005	.007	.008	.010	.012	M-42

Reaming

Speed, fpm	High-Speed Tool							Carbide Tool	
	Feet, ipr						Tool Material	Speed, fpm	Tool Material
	Reamer Diameter, Inches								
	1/8	1/4	1/2	1	1-1/2	2			
25	.002	.003	.005	.007	.010	.012	M-7	80	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	55	.001	.002	.003	.004	M-2; M-7	200	.0015	.0025	.004	.005	C-6

Broaching

Speed, fpm	Chip Load, Inches per tooth	Tool Material
10	.002	M-42

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	.005
10	10	6	4	85	.003
10	10	6	4	55	.005
10	8	6	4	75	.003

Figures used for all metal removal operations 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.

Additional Machinability Notes

Figures used for all metal removal operations 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.

Grinding and Polishing

Hampden tool steel, designed primarily to resist wear and abrasion, should be expected to present some difficulty in grinding after hardening. Soft wheels with the largest possible grain size, consistent with the finish required, should be used. Light cuts and the use of generous amounts of coolant will minimize the danger of grinding damage. It is advisable to consult grinding wheel manufactures for aid on specific problems.

Other Information

Wear Resistance

The wear characteristics shown in the following chart were generated using ASTM G65 Procedure A, the ASTM Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests. The data are presented as a volume loss as required by the ASTM Standard. Note, therefore, that a lower number indicates better wear resistance.

Dry Sand/Rubber Wheel Abrasion Test - Hampden Tool Steel
All specimens oil quenched from 1775°F (969°C) and tempered 1 hour.

Tempering Temperature		Rockwell C Hardness	Average Volume Loss ASTM
°F	°C		
As-Hardened		66/67	24.6
300	149	64.5	23.9
400	204	62	28.9
600	316	60	30.1
900	482	57	31.7
1025	552	50	39.1
1100	593	47	48.2
1200	649	39/40	64.3

Applicable Specifications

- ASTM A681
- QQ-T-570

Forms Manufactured

- Bar-Rounds
- Billet

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