steel tool O1

Identification

UNS Number

• T31501

AISI Number

• Type O1

Type Analysis

Single figures are nominal except where noted.

Carbon	0.90 %	**Manganese**	1.20 %
Chromium	0.50 %	**Vanadium**	0.20 %
Tungsten	0.50 %	**Iron**	Balance

General Information

Description

CarTech 01 is a manganese-chromium-tungsten, nondeforming, oil hardening general purpose tool and die steel which is safe to harden, even in intricate sections.

It is produced from billets that are 100% acid disc inspected and ultrasonic tested, insuring sound metal in the finished bars.

Applications

CarTech 01 has found applications in the following types of tools and dies:

Blanking dies
Forming dies
Lamination dies
Molding dies
Trimming dies
Broaches
Collets
Stamps
Master tools
Spindles
Master taps
Thread gauges

Properties

Physical Properties

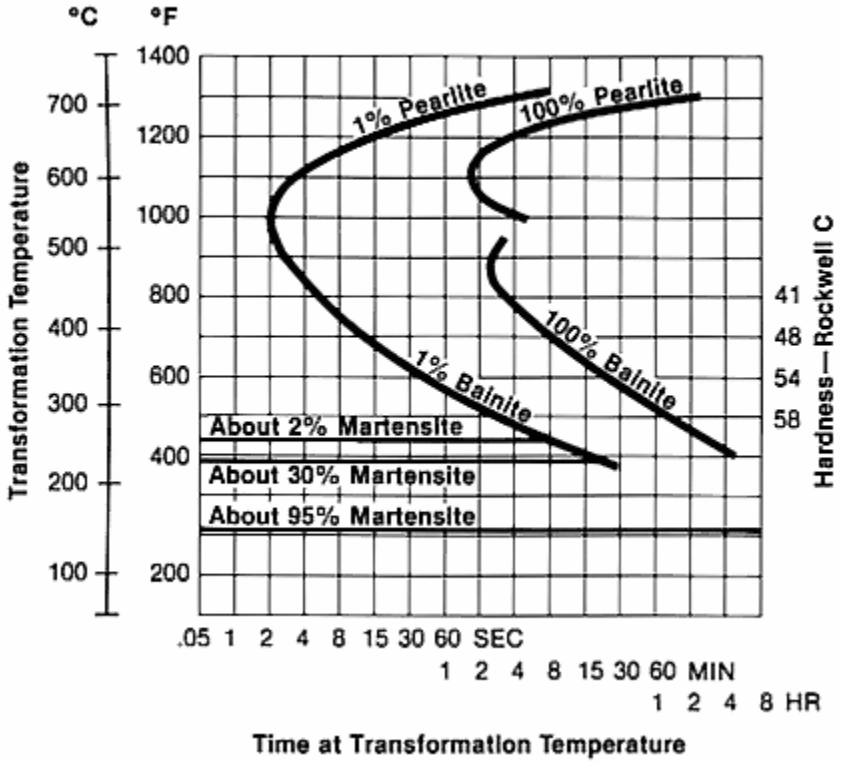
Specific Gravity	7.87	
Density	0.2830	lb/in³
Mean CTE		
100 to 500°F	6.00	x 10 $^{-6}$ in/in/°F
100 to 800°F	7.10	x 10 $^{-6}$ in/in/°F
100 to 1000°F	7.80	x 10 $^{-6}$ in/in/°F
100 to 1200°F	8.00	x 10 $^{-6}$ in/in/°F

Coefficient of thermal expansion

From 100°F to	38°C to	10^{-6}/°F	10^{-6}/°C
500	260	6.0	10.8
800	427	7.1	12.8
1000	538	7.8	14.0
1200	649	8.0	14.4

Modulus of Elasticity (E) 31.0 x 10^{3} ksi

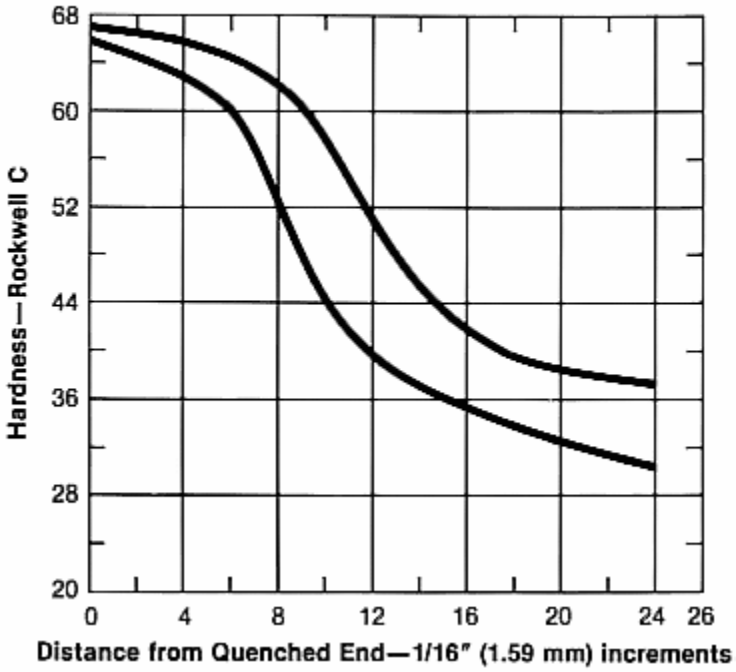
Isothermal transformation diagram
Austenitizing temperature—1490°F (810°C)



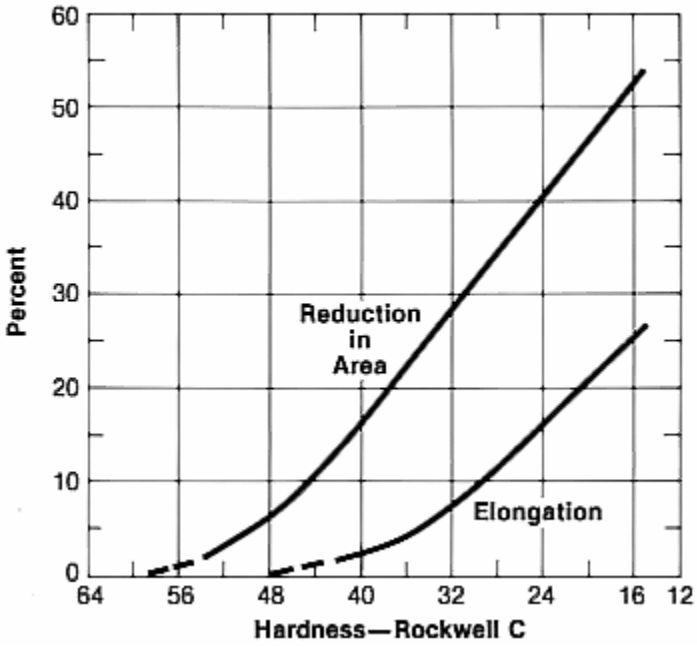
Critical Temperature (AC1) 1370 °F

Typical Mechanical Properties

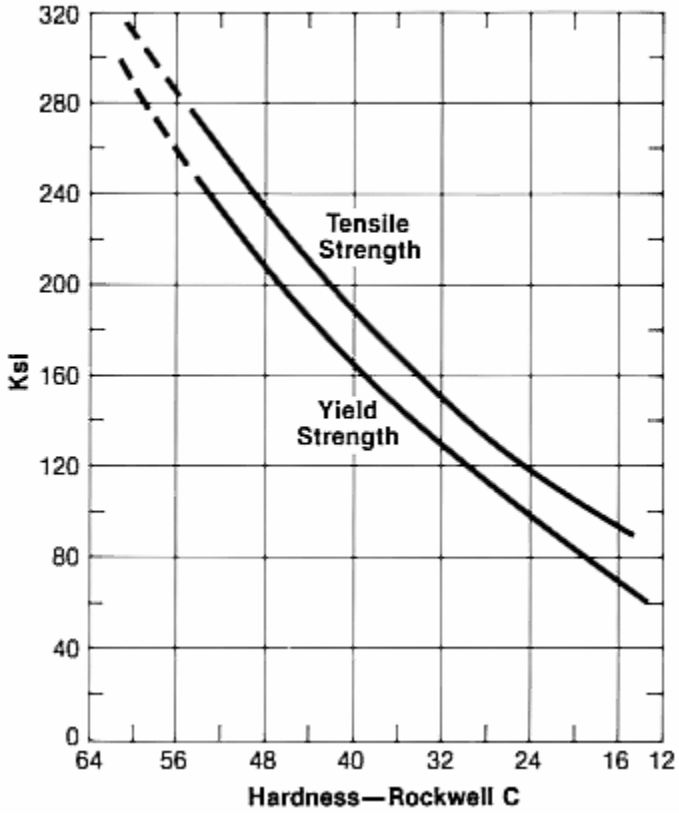
Jominy Hardenability
Austenitized—1475°F (802°C)



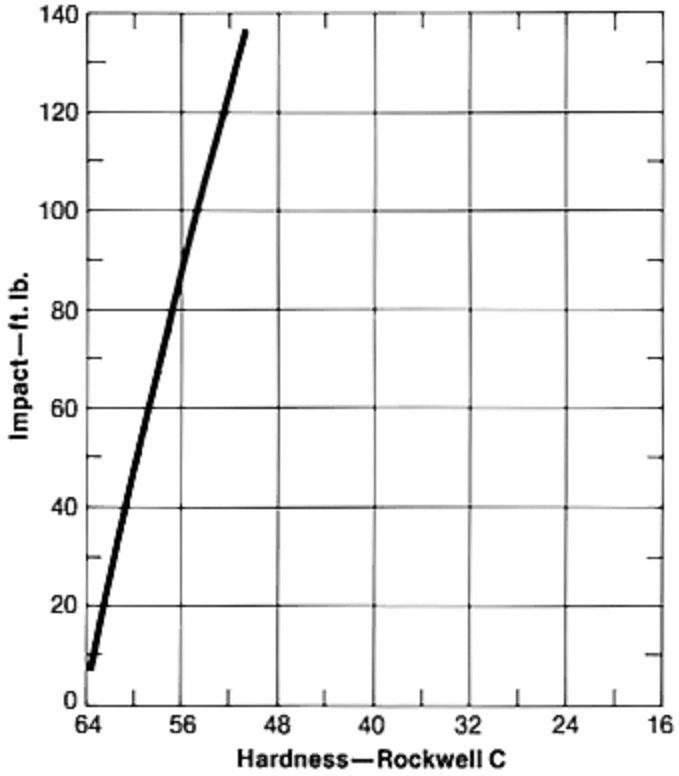
Percent Elongation in 2" (50.8 mm) and Reduction in Area



Tensile and Yield Strength



Un-notched Izod Impact



Heat Treatment

Decarburization

01 has no special tendency to decarburize. If the hardening instructions are carefully followed, tools should be hard right out to the surface.

Normalizing

Forgings can be normalized by heating uniformly to 1600°F (871°C), then cooling in still air. This procedure is suitable for large forgings.

Annealing

01 should be packed in a suitable container using a neutral packing compound or placed in a controlled atmosphere furnace.

Heat uniformly to 1400/1450°F (760/788°C), then cool very slowly in the furnace at a rate of not more than 20°F (11.1°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 217.

Hardening

01 may be hardened from temperatures between 1450/1500°F (788/816°C). Endothermic atmospheres should be held to dew point limits between 45/55°F (7/18°C). This wide hardening range makes it possible to fit into many heat treating schedules during the average day. This broad a hardening range supersedes all other references to 01 hardening temperatures previously published.

Without preheating, place the tool right in the hot furnace and let it heat naturally until its color uniformly matches the color of the thermocouple in the furnace. Soak an additional 5 minutes per inch of thickness, then quench in oil. The temperature of the tool should be brought right down to the temperature of the oil in the quench.

The basket in the quenching tank serves as a good place to store hardened tools while waiting to be tempered.

01 is an easy tool to harden. Simply heat it, soak it, then quench it. This procedure saves time and trouble, is the safest procedure and yields better tools.

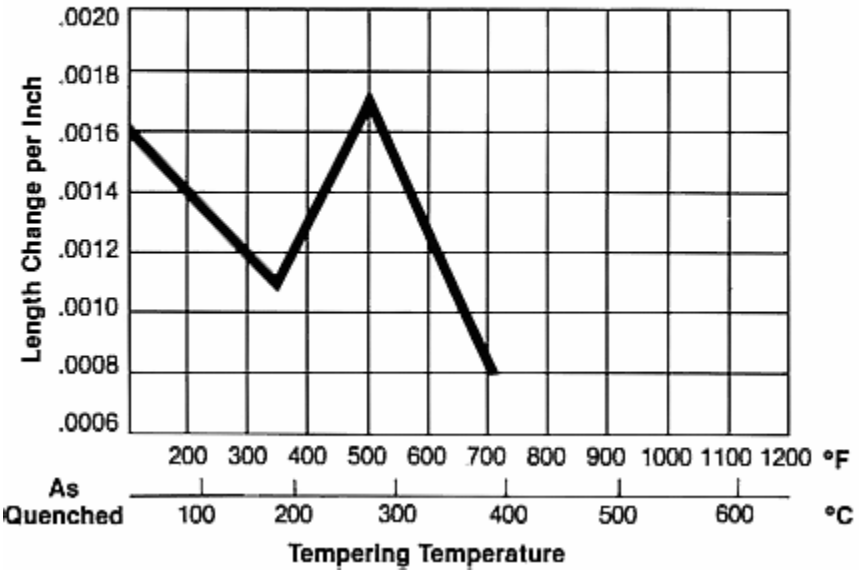
Deformation (Size Change) in Hardening

The accompanying hyperlink entitled "Size Change in Hardening" shows typical length changes of 01 when it has been properly hardened and tempered. Note that the length change information is presented in inches per inch of original length.

When properly hardened, 01 will expand slightly, but will return close to its original size upon tempering.

The data show the average size change in this steel per inch of length. That is, a piece 1" long will expand approximately 0.002" (0.0051 mm) when hardened, but when tempered between 300/400°F (149/204°C) will return within 0.001" (0.0025 mm) or its original size.

Size Change of 01
1″ (25.4 mm) round x 4″ (101.6 mm) long specimens
Austenitized 20 minutes at 1475°F (800°C), oil quenched,
then tempered 1 hour at indicated 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), hold at heat for a minimum of 1 hour, then cool slowly. After cooling, the part or parts may be finish machined.

Tempering

Temper 01 immediately to the desired hardness level. The minimum tempering time is 1 hour at temperature. Be sure to allow sufficient time to allow the material to reach the proper temperature. Sections over 2 inches thick should be tempered one hour per inch.

The effects of different tempering temperatures on the hardness of 01 are shown in the hyperlink entitled "Effect of Tempering Temperature on Hardness".

Effect of Tempering Temperature on Hardness of 01
Oil quenched from 1475°F (802°C), tempered 1 hour at indicated temperature

Tempering Temperature		Rockwell C Hardness
°F	°C	
As Hardened		63/65
200	93	63/65
300	149	63/65
350	177	62/64
400	204	60/63
450	232	60/62
500	260	58/60
600	316	55/57
700	371	52/54
800	427	48/50
900	482	44/47
1000	538	40/44

Workability

Forging

Heat slowly and uniformly to 1800/1900°F (982/1038°C), then proceed to forge. Do not work below 1500°F (816°C). Cool forgings slowly in ashes, lime or in the furnace.

Machinability

The machinability of 01 may be rated between 65/75% of a 1% carbon water hardening tool steel or approximately 50/60% of B1112.

Approximate turning speeds of 90/105 surface feet per minute (SFPM) (0.46/0.53 m/s) are suggested when using high speed cutting tools.

Other Information

Applicable Specifications

• ASTM A681

Forms Manufactured

• Bar-Rounds

Technical Articles

• A New Guide for Selecting Ferrous Alloys, Tungsten Carbides and Ceramics for Tooling

Edition Date: 05/01/1986

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