

Crucible Data Sheet

Issue #8

CRUCIBLE 440C is a hardenable chromium steel. It has one of the highest attainable hardnesses of the corrosion and heat resisting grades. This grade is magnetic at all times.

For those applications where superior machinability is desired and where slightly lower corrosion resistance is satisfactory, CRUCIBLE 440F can be supplied.

Typical Applications

Ball bearings	Bushings
Valve parts	Cutlery

Note: The above are some *typical* applications. Your *specific* application should not be undertaken without independent study and evaluation for suitability.

Forging

CRUCIBLE 440C should be forged at 1950 to 2050 F and finished not lower than 1750 F. Reheating should be used if necessary. This grade should be allowed to cool slowly after forging.

Annealing

CRUCIBLE 440C should be annealed for maximum softness by thorough soaking at 1650 F for six hours followed by a furnace cool. This grade can be *cycle annealed by heating to 1600 F, holding two hours, cooling to 1300 F, and holding four hours. The steel may be cooled in air if desired.

*Cycle (isothermal) annealing is most practical for applications in which full advantage may be taken of the rapid cooling to the transformation temperature, and from this temperature down to room temperature. Thus, for small parts which can be conveniently han-

Note: Temperatures shown throughout this data sheet are metal temperatures.

CRUCIBLE 440C STAINLESS STEEL

Carbon	0.95/1.20%
Manganese	1.00% max.
Silicon	1.00% max.
Phosphorus	0.40% max.
Sulfur	0.03%
Chromium	16.00/18.00%
Molybdenum	0.75% max.



dled in salt or lead baths, this isothermal annealing makes possible large time savings as compared with the conventional slow furnace cooling. The method offers no particular advantage for applications such as batch annealing of large furnace loads in which the rate of cooling to the center of load may be so slow as to preclude any rapid cooling to the transformation temperatures. For such applications, the conventional full annealing method usually offers a better assurance of obtaining the desired microstructure and properties.

The recommendation for cycle annealing is based on the principles explained in P. Payson's "The Annealing of Steel" which appeared in Iron Age, June and July issues, 1943.

Hardening and Tempering

CRUCIBLE 440C can be hardened for maximum hardness by oil quenching or air cooling from 1850 to 1900 F. Large sections or complex parts should be preheated to 1425 F, equalize, and then raised to the austenitizing temperature. If the finished part is not to be ground and polished, the surface may be improved by packing in a neutral material during heating. Tempering should

be at the proper temperature to give the desired approximate hardness as indicated below.

Tempering Temperature (°F)	Hardness Rockwell C
As quenched	59
212	59
400	56
600	54
800	55
1000	51

It is desirable to avoid tempering between 800 and 1100 F, as there is a drop in impact strength within this range, coincidental with which there is also a reduction in resistance to corrosion.

Welding

CRUCIBLE 440C should be welded with Type 440C filler weld metal if the mechanical properties of the weld metal must be similar to those of the parent metal. In welding annealed material, the steel should be preheated to 600 F and annealed following welding by heating uniformly and thoroughly at 1300 F followed by air cooling. When welding hardened and tempered material, preheat to the tempering temperature, weld, and post-heat at the appropriate tempering temperature for 2 hours.

Resistance to Scaling

CRUCIBLE 440C scales at approximately 1400 F. This temperature will vary with the type of atmosphere, type of construction, and cycle of operation.

Specifications

CRUCIBLE 440C has found wide industry acceptance and meets the following specifications:

QQ-S-763d	AMS 5630C	ASTM A-276-67	ASTM A-580-67
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General Corrosion Resistance

CRUCIBLE 440C is resistant to corrosion in atmosphere environments, fresh water, mild acids, alkalies, and fruit and vegetable juices. The better the finish of the hardened and tempered part, the better will be its corrosion resistance.

Cutlery Applications

CRUCIBLE 440C is particularly designed for cutlery applications requiring a high hardness and an excellent retention of the cutting edge. When this grade is ordered specifically for mirror-finish cutlery applications, material will be supplied which has been processed in such a manner as to insure the obtaining of a polished surface of "mirror-finish" quality. Care should be taken in grinding and polishing this grade so that excessive heat is not produced by this operation as the resistance to staining will be lowered. In general, CRUCIBLE 440C resembles tool steels in that it requires great care in fabrication and hardening.

Machining Data

Operation	Tooling Width or Depth of Cut (in)	High Speed Tooling*		Carbide Tooling	
		Speed (fpm)	Feed (in/rev)	Speed (fpm)	Feed (in/rev)
Turning single point	0.050	65	0.0045	200	0.010
	0.250	65	0.0040	200	0.020
	0.500	60	0.0035	175	0.025
Forming	1/2 wide	65	0.0012	120	0.002
	1 wide	65	0.0010	120	0.002
	1½ wide	60	0.0008	120	0.002
	2 wide	60	0.0008	120	0.001
Cutoff	1/16 wide	60	0.0010	120	0.002
	1/8 wide	60	0.0010	120	0.002
	3/16 wide	65	0.0012	120	0.002
	1/4 wide	65	0.0015	120	0.003
Drilling	1/16 dia.	40	0.0010		
	1/8 dia.	40	0.0020		
	1/4 dia.	45	0.0025		
	1/2 dia.	45	0.0030		
	3/4 dia.	45	0.0035		
	1 dia.	45	0.0040		

†Use the higher speeds for the finer threads.

*Details on tool life test techniques and Crucible High Speed and Tool Bit recommendations are described in the booklet, "Machining Crucible Stainless Steels."

Physical Properties

Modulus of elasticity in tension, 1000 psi.	29,000
Specific gravity.	7.75
Density (lb.)/(cu.in.).	0.276
Specific electrical resistance (microhm-centimeters), Room temperature.	59.9
Specific heat (BTU/lb.)/(°F)—(32-212°F).	0.11
Thermal conductivity (BTU ft.)/hr. sq. ft. °F) 200°F.	14.0
Mean linear coefficient of thermal expansion (in/in)/(°F).	
32-212°F.	5.7 x 10 ⁻⁶
32-600.	6.0
Melting point range (°F).	2500/2700

Mechanical Properties

(All values are representative properties in the annealed condition):

	<u>Bar (1 in. rd.)</u>
Tensile strength, 1000 psi.	110
Yield strength (0.2% offset), 1000 psi.	65
Elongation in 2 in., %	14
Reduction of area, %	25
Hardness.	230 BHN

TTT Curve :

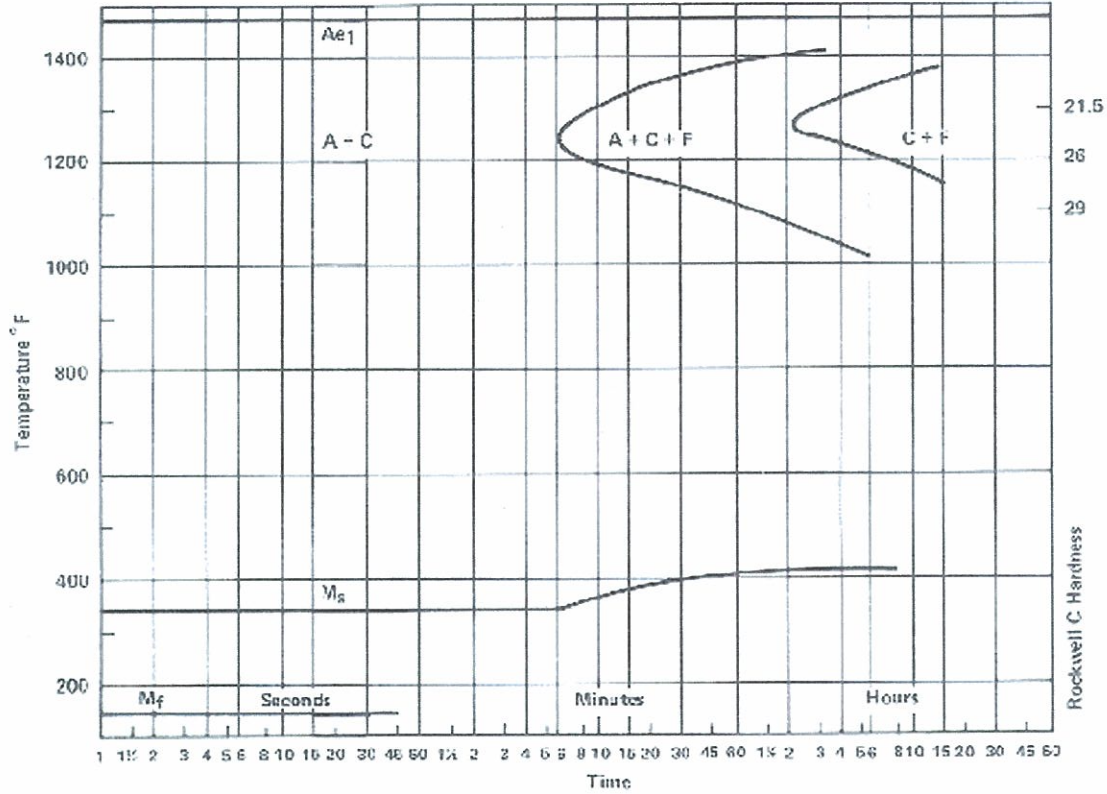
Grade-CRUCIBLE 440C

Austenitizing temperature -1900° F

Critical temperature (AC1)-1480° F

Prior condition-annealed

C	Mn	P	S	Si	Ni	Cr	Mo
1.02	0.54	0.010	0.010	0.52	0.18	16.91	0.49



Note: Properties shown throughout this data sheet are typical values. Normal variations in chemistry, size, and conditions of heat treatment may cause deviations from these values.



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