Crucible Data Sheet

Issue #7

CRUCIBLE 431 STAINLESS STEEL

Carbon	**0.20% max.**
Phosphorus	**0.04% max.**
Manganese	**1.00% max.**
Sulfur	**0.03% max.**
Silicon	**1.00% max.**
Chromium	**15.00/17.00%**
Nickel	**1.25/2.50%**

CRUCIBLE 431 is a nickel bearing chromium steel which can be treated to exceptionally high physical properties. In the heat treated condition, its corrosion resistance is superior to similar martensitic types. This grade is ferro-magnetic when annealed or heat treated. Because it is characteristically a two phase alloy, the normal structure contains ferrite and martensite with typical properties as shown on page 4. However, depending upon application, the chemistry can be balanced to provide an essentially ferrite-free structure and higher mechanical properties.

Typical Applications:

Aircraft Fittings
Bolting Materials
Paper Machinery
Jordan and Beater Bars

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

Forging:

CRUCIBLE 431 should be forged at 2100 to 2250 F. It should be finished above 1400 F. Reheating should be used if necessary. When it is to be upset, temperatures should be such that the work is finished between 1450 and 1600 F.

Hardening and Tempering:

CRUCIBLE 431 may be hardened by either air cooling or oil quenching from 1800 F to 1950 F. This grade is a deep hardening steel and large sections may be hardened through with either an air or oil quench.

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

Tempering should be done at the proper temperature level to give the desired properties as indicated in Figure 2. Tempering between 800 F and 1100 F should be avoided as there is a drop in impact properties and corrosion resistance within this range. This condition disappears when the tempering temperature is above 1100 F.

Although corrosion resistance is enhanced by quenching from 1900/1950 F, mechanical properties such as impact strength are usually better after a quench from 1800 F and tempering at 1100 F or higher.

Annealing:

The long slow cool cycle required to full anneal this grade makes it impractical for most purposes. It can be annealed, however, by normalizing from 1600 F, reheating to 1200 F for 10 to 12 hours and air cooling.

Attainable Hardness:

The maximum attainable hardness of CRUCIBLE 431 can be varied within the

limits of analysis to suit the requirements of particular applications. Attainable hardness is defined as the hardness obtained on quenching a sample approximately ½" in thickness in oil from 1900 F. This hardness is indicative of the mechanical properties of the material which might be expected after hardening and tempering. The attainable hardness is, in general, between 375 and 444 Brinell.

It is recommended, therefore, when a specific hardness is required after a specified heat treatment, that special attention be given in ordering, so that material of suitable attainable hardness can be supplied.

Welding:

CRUCIBLE 431 should be welded using Type 431 Electrodes. This steel is susceptible to air hardening and cracking unless the material is preheated to a minimum temperature of 300 F prior to welding, and is post-heated directly after welding by heating to 1200 F, followed by an air cool.

Resistance to Scaling:

CRUCIBLE 431 scales at approximately 1600 F. This temperature will vary with the type of atmosphere, type of construction and cycle of operation.

General Corrosion Resistance:

The general corrosion resistance of CRUCIBLE 431 is the best of the hardenable chromium stainless steels.

Galvanic Corrosion in Salt Water:

CRUCIBLE 431 is not subject to galvanic corrosion in contact with brasses and bronzes in the presence of sea water.

Specifications

CRUCIBLE 431 has found wide industry acceptance and meets the following specifications:

QQ-S-763	MIL-S-18732	AMS 5628	ASTM A-276	ASTM A-580

Machining data

Operation	Tool Width or Depth of Cut (in)	CRUCIBLE 431 High Speed Tooling		Carbide Tooling	
		Speed (fpm)	Feed (in/rev)	Speed (fpm)	Feed (in/rev)
Turning single point	0.050	75	0.0045	250	0.010
	0.250	75	0.0040	200	0.020
	0.500	75	0.0030	175	0.025
Cutoff	1/16 wide	75	0.0010	150	0.0020
	1/8 wide	75	0.0012	150	0.0020
	3/16 wide	80	0.0012	175	0.0022
	1/4 wide	80	0.0015	175	0.0030
Drilling	1/16 dia.	45	0.0015		
	1/8 dia.	50	0.0020		
	1/4 dia.	50	0.0030		
	1/2 dia.	50	0.0035		
	3/4 dia.	55	0.0040		
	1 dia.	55	0.0050		

†Use the higher speeds for the finer threads.

Physical Properties:

Modulus of Elasticity in Tension—psi	29,000,000
Electrical Resistivity	
Room Temperature — microhm-cm	72
Specific Heat — Btu/lb./° F (32-212 F)	0.11
Specific Gravity	7.77
Weight — lb./cu. in.	0.281
Thermal Conductivity — Btu/hr./sq. ft./° F/ft.	
At 200 F	11.7
Mean Coefficient of Thermal Expansion — in/in/° F x 10^{-6}	
32-212 F	6.5
32-600 F	6.7
Melting Point Range — ° F	2600/2700

Mechanical Properties:

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

	Bar-1 in. Rd.
Tensile Strength, psi	125,000
Yield Strength (0.2% Offset), psi	95,000
Elongation in 2 in., per cent	20
Reduction of Area, per cent	55
Izod Impact Resistance, ft. lbs.	50
Hardness	260 BHN

Thermal Expansion:

Hardened 1850 F—½ Hr., Oil Quench.
Tempered 1150 F, 2 Hrs.

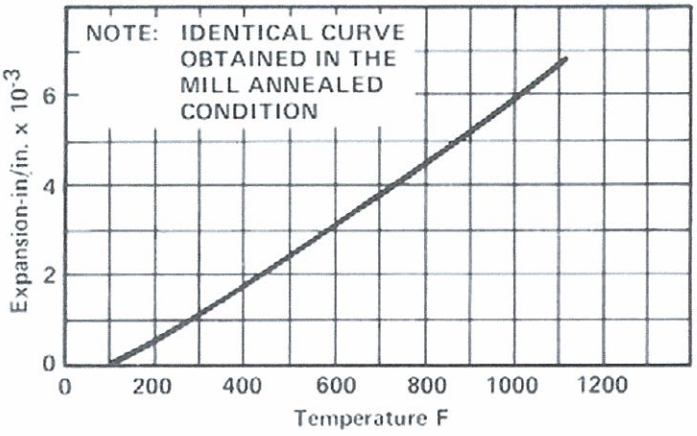

Figure 1

Mechanical Properties as Heat Treated:

Chemical Analysis: C—0.14%, Mn—0.72%, Si—0.30%, Cr.—16.60%, Ni—1.45%.
Heat Treatment : 1900 F Oil Quench, Temper—3 Hrs.
Size: 1 in. Rd., Tensile 0.505 in Dia., Izod Notched 0.394 in. sq.

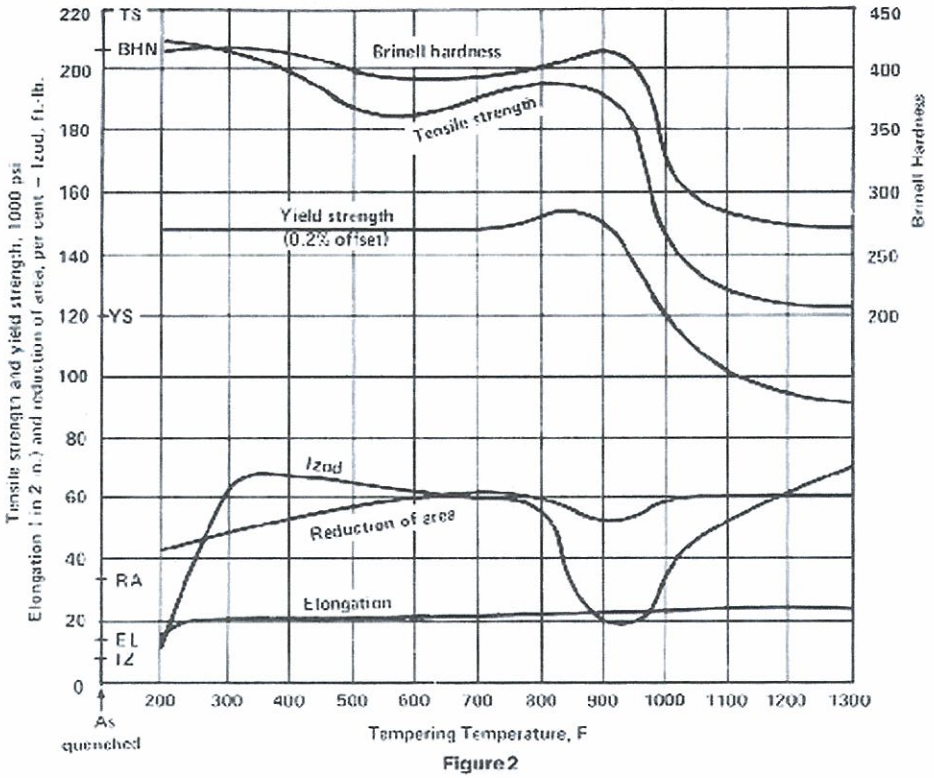

Figure 2

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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