Crucible Data Sheet

Issue no. 9

CRUCIBLE 321 STAINLESS STEEL

(AISI 321)

Carbon	**0.08% Max.**
Manganese	**2.00% Max.**
Phosphorus	**0.45% Max.**
Sulfur	**0.03% Max.**
Silicon	**1.00% Max.**
Chromium	**17.00/19.00%**
Nickel	**9.00/12.00%**
Titanium	**5 x C Min.**

CRUCIBLE 321 is a non-hardenable austenitic chromium-nickel steel which is particularly adaptable for parts fabricated by welding without postweld annealing for use at temperatures between 800 and 1500 F. This grade is non-magnetic in the annealed condition but is slightly magnetic when cold worked.

Typical Applications

Aircraft Engine Exhaust Manifolds
Furnace Parts
Collector Rings
Expansion Joints
High Temperature Chemical Handling Equipment

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

Forging

CRUCIBLE 321 should be preheated, then forged at 2000 to 2200 F and finished above 1700 F. Reheating should be used if necessary. Rapid cooling should be employed if subsequent annealing is impractical.

When CRUCIBLE 321 is to be upset, temperatures should be such that the work is finished between 1700 and 1800 F.

Annealing

For maximum softness, CRUCIBLE 321 should be annealed at 1750 to 1900 F followed by an air cool for sheet and light plates. Heavier sections require a water quench from the annealing temperature. For best corrosion and heat resistance, a final anneal between 1750 and 1850 F is recommended.

Hardening

CRUCIBLE 321 in small or thin sections can be hardened by cold working, however, it greatly reduces the creep ductility at high temperatures (1100-1200° F).

Forming

The forming properties of CRUCIBLE 321 vary within composition limits. It is recommended, therefore, when severe forming operations are planned, that special attention be given in ordering, so that material having suitable properties can be supplied.

Since this steel is susceptible to work hardening, an anneal should precede and follow each drastic forming operation.

Machining

CRUCIBLE 321 is characterized by its work hardening properties. For that reason, the feed used should be as heavy as possible within the limits of the machine and the tool material. A high metal removal rate may be obtained by using heavy feeds at relatively low surface speeds. Precautions should be taken to prevent the tool from riding on or glazing the work, and both work and tools should be rigidly supported to prevent or

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

minimize chatter. It is essential that the tools used for machining this grade be kept sharp, as a dull tool would tend to harden the surface by a rubbing action. Complete breakdown of the tool will invariably create a hard spot which might be difficult to remove. For general turning. speeds are approximately 50% of those for mild carbon steels. More complete information is given in the CRUCIBLE MACHINABILITY DATA SHEET.

Welding

CRUCIBLE 321 should be welded using Type 347 coated electrodes. If an inert gas method is used, TIG or MIG, Type 321 or Type 347 filler weld metal can be used. Type 321, because of its resistance to intergranular corrosion, is recommended for those applications where the welded product cannot be annealed subsequent to welding and is to come into contact with active electrolytes.

Resistance to Scaling

CRUCIBLE 321 scales at approximately 1650 F. This temperature will vary with the type of atmosphere, type of construction and cycle of operation.

General Corrosion Resistance

The general corrosion resistance (intergranular corrosion excluded) of CRUCIBLE 321 is practically the same as that for CRUCIBLE 302.

Intergranular Corrosion

When 18-8 chromium-nickel steels are heated within the range of 800-1650 F, carbides are precipitated at the grain boundaries. If these grades are then exposed to active electrolytes, the zones of precipitated carbides are subject to failure by intergranular corrosion. An annealing treatment of 1800 F or above will cause the precipitated carbides to be dissolved, making the material homogeneous and therefore not subject to intergranular corrosion. The presence of an active carbide former such as titanium in CRUCIBLE 321 practically eliminates the possibility of excess carbide precipitating in the grain boundaries during heating in this 800 to 1650 F range. Therefore this steel has satisfactory resistance to corrosion without a subsequent annealing treatment.

Specifications

QQS-763	MIL-S-862	AMS 5645	ASTM A-276

Physical Properties

Modulus of elasticity in tension, psi	28,000,000
Specific gravity	7.89
Density (lb.)/(cu. in.)	0.285
Specific heat (BTU/lb.)/(°F)—(32-212°F)	0.12
Specific electrical resistance (Microhm-Centimeters), Room temperature	72.0
Thermal conductivity (Btu ft.)/(hr. sq. ft. °F)	
200 F	9.3
1000	12.7
Mean linear coefficient of thermal expansion (in/in)/(°F)	
32- 212 F	9.3×10^{-6}
32- 600	9.5
32-1000	10.3
32-1200	10.7
32-1800	11.2
Melting Point Range (°F)	2250/2600

Mechanical Properties

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

Room Temperature

	Bar-1 in. Rd.
Tensile Strength, psi	85,000
Yield Strength (0.2% Offset), psi	35,000
Elongation in 2 in., per cent	55
Reduction of Area, per cent	65
Izod Impact Resistance, ft. lbs.	100
Hardness	160 BHN
Erichsen Value, mm.	
Olsen Value	
Cold Bend, deg.	180

*Elongation values vary with size, being higher with greater thickness.

Elevated Temperature

Short Time Elevated Tensile Strength

Temperature F	Tensile Strength psi
1300	36,500
1500	22,000
1700	15,000

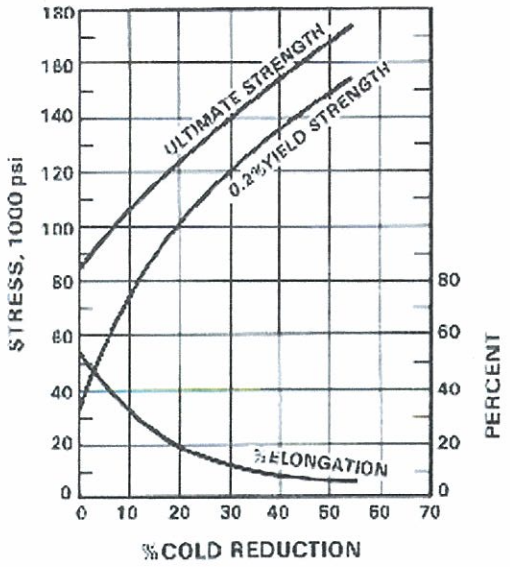
Creep Data

Temperature F	Stress for Creep Rate of 0.0001% per Hour psi
1000	18,000
1100	13,000
1200	8,000
1300	4,500
1500	850

Stress Rupture Data

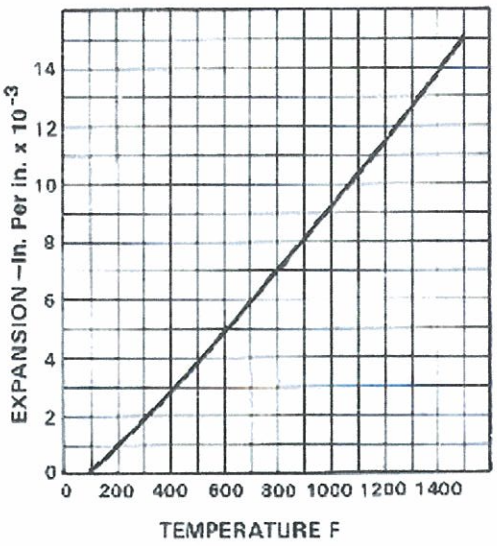
Test Temperature F	Stress (1000 Psi) for Rupture in 1,000 Hrs.	Stress (1000 Psi) for Rupture in 10,000 Hrs.
1100	27.0	16.0
1200	17.5	9.8
1300	10.0	6.0
1400	5.6	3.6
1500	3.7	2.2

Mechanical properties as cold worked



Thermal Expansion

Annealed—2050 F, water quench



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

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