

Fe
25 Cr
20 Ni
2 Si

Type 314

1 GENERAL
This non-heat treatable stainless steel is generally used in the annealed condition. In this condition it possesses excellent general corrosion resistance and has the highest resistance to scaling and carburization of any of the austenitic Cr-Ni alloys. It is used primarily for parts and welded assemblies requiring both corrosion and oxidation resistance up to 2000 F. Its high silicon content improves corrosion resistance over other austenitic Cr-Ni steels, but with some sacrifice in ductility and weldability. This alloy is subject to embrittlement after long-time exposure at 1200 to 1600 F (2, 5, 7).

1.01 Commercial Designation
Type 314.

1.02 Alternate Designations
SAE 30314 and UNS S31400.

1.03 Specifications
1.031 Specifications, Table 1.031.

1.04 Composition
1.041 Composition, Table 1.041.

1.05 Heat Treatment
1.051 Anneal (solution treat) 1900 to 2100 F, rapid air cooling (sheet and light plates) or water quench (heavier sections) (5, 7).
1.052 Final anneal at 1900 F, minimum, is recommended to relieve strain and achieve best corrosion resistance and high temperature properties (5).

1.06 Hardness
1.061 Alloy is normally strengthened by cold work. (See Figure 3.0212 and Section 3.043.)
1.062 Aging at 1650 F with or without prior cold work causes a hardness peak after about 300 hours. A milder peak occurs after aging at 1740 F for 1 to 10 hours, shown in Figure 1.063. These hardness increases are attributed to precipitation of fine acicular particles within the matrix and coarser particles at the grain boundaries. The precipitate is an intermetallic compound containing approximately 35Cr, 47Fe, and 18Ni, presumably sigma phase. The amount of $M_{23}C_6$ carbide precipitate also increases during aging (8).
1.063 Room temperature hardness of cold worked and annealed alloy, Figure 1.063 [(a) 1650 F and (b) 1740 F].

1.07 Forms and Conditions Available
1.071 The alloy is available in bar, sheet, strip, plate, tubing and wire (7).

1.08 Melting and Casting Practice
Electric furnace melt.

1.09 Special Considerations
Prolonged exposure at 1200 to 1600 F may cause embrittlement through carbide precipitation and sigma phase formation. Ductility may be restored by annealing at 1900 to 1950 F for 10 to 60 minutes. This treatment is recommended after 1000-hr exposure at 1400 to 1600 F (5, 7).

2 PHYSICAL PROPERTIES AND CHEMICAL PROPERTIES

2.01 Thermal Properties
2.011 Melting range, 2500 to 2600 F (5).
2.012 Phase changes, none.
2.0121 Time-temperature-transformation diagrams.
2.013 Thermal conductivity, Table 2.013.
2.014 Thermal expansion, Figure 2.014.
2.015 Specific heat, 0.12 Btu/lb F, 32 to 212 F (5, 7).
2.016 Thermal diffusivity.

2.02 Other Physical Properties
2.021 Density, 0.279 lb/in.³, 7.72 g/cm³ (5, 7).
2.022 Electrical resistivity, 30.31 microhm-in. at 68 F (7).
2.023 Magnetic properties. Alloy is nonmagnetic.
2.024 Emissance.
2.025 Damping capacity.

2.03 Chemical Properties
2.031 Corrosion.
2.0311 This alloy has excellent general corrosion resistance, comparable to 18 Cr-8 Ni austenitic stainless steels. It is slightly inferior to Type 310 under wet corrosion conditions (7).
2.0312 Type 314 exhibits good resistance to fuming nitric acid at room temperature and to fused nitrates up to 800 F (7).
2.0313 This alloy is particularly recommended for handling SO₂ gas, but is inferior to Type 311 where a high percentage of SO₃ is present (5).
2.032 Oxidation.
2.0321 Type 314 has the highest scale resistance of any of the austenitic Cr-Ni stainless steels, because of its high silicon content and lower coefficient of expansion, tending to form a more tightly adherent film, particularly in the range 1200 to 1600 F (5, 7).
2.0322 Recommended maximum operating temperatures are 1900 F for intermittent service and 2100 F for continuous service (7).
2.033 Carburization.
2.0331 Type 314 has good resistance to carburization in high temperature carbonaceous atmospheres relative to other austenitic stainless steels. This behavior is attributed to its high silicon content, which causes a dramatic decrease in the amount of carbon absorbed. The weight gain behavior of electropolished Type 314 in hydrogen-methane gas mixtures, shown in Figure 2.0332, is approximately parabolic, indicating a diffusion-controlled reaction. The uptake of carbon after 100 hours at 1830 F under these conditions is large, as seen from the concentration profile in Figure 2.0333. Oxidation of the alloy to form a continuous Cr₂O₃ surface scale can be induced by the presence of water vapor in the gas stream; this minimizes carburization and accompanying deleterious effects on mechanical properties up to exposure temperatures of about 1700 F (9).
2.0332 Carburization weight gain of Type 314 in hydrogen-methane gas at elevated temperatures, Figure 2.0332.
2.0333 Carbon concentration profile through thickness of specimen after exposure to hydrogen-methane gas mixture for 100 hours at 1830 F, Figure 2.0333.

2.04 Nuclear Properties

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3	MECHANICAL PROPERTIES	3.05	Fatigue Properties
3.01	Specified Mechanical Properties	3.06	Elastic Properties
3.011	AMS specified mechanical properties at room temperature, Table 3.011.	3.061	Poisson's ratio.
		3.062	Modulus of elasticity, 29,000 ksi at room temperature (4, 5).
3.02	Mechanical Properties at Room Temperature	3.063	Modulus of rigidity.
3.021	Tension—stress-strain diagrams—tension properties.	3.064	Tangent modulus.
3.0211	Typical mechanical properties for bar, plate, sheet, and wire, Table 3.0211.	3.065	Secant modulus.
3.0212	Effect of cold work on room temperature properties of bar, Figure 3.0212.	4	FABRICATION
3.0213	Effect of long-time exposure at elevated temperatures on room temperature elongation of annealed alloy, Figure 3.0213.	4.01	Forming
3.022	Compression—stress-strain diagrams—compression properties.	4.011	An anneal prior to forming operations is recommended since the alloy is susceptible to work hardening.
3.023	Impact.	4.012	Forging. Starting temperature at 1900 to 2050 F, maximum, finishing temperature at 1700 F, minimum. For upset forgings, work should be finished between 1700 and 1850 F (5, 6).
3.024	Bending.	4.02	Machining and Grinding
3.025	Torsion and shear.	4.021	General. Because of work hardening the feed should be as heavy as possible in order to obtain a high metal removal at a relatively low surface speed. Sharp tools at all times are necessary. Sulfurized cutting oils diluted with paraffin oil are recommended (5, 7).
3.026	Bearing.		
3.027	Stress concentration.		
3.0271	Notch properties.		
3.0272	Fracture toughness.		
3.028	Combined properties.		
3.03	Mechanical Properties at Various Temperatures		
3.031	Tension—stress-strain properties—tension properties.		
3.0311	Short time tension properties of annealed bar and sheet at elevated temperatures, Figure 3.0311.	4.03	Joining
3.032	Compression—stress-strain diagrams—compression properties.	4.031	General. The alloy can be welded by gas or arc methods without the use of pre- or postheat. However, annealing is recommended after welding for maximum corrosion resistance (7). Type 310 electrodes are recommended (5).
3.033	Impact.		
3.034	Bending.		
3.035	Torsion and shear.	4.032	
3.036	Bearing.		
3.037	Stress concentration.	4.04	Surface Treating
3.0371	Notch properties.		
3.0372	Fracture toughness.		
3.038	Combined properties.		
3.04	Creep and Creep-Rupture Properties		
3.041	Creep rupture strength at 1200 to 1800 F, Figure 3.041.	1	REFERENCES
3.042	Creep curves for annealed sheet at 1200 to 1800 F, Figure 3.042.	2	AMS 5522D (January 15, 1978).
3.043	Prior cold work usually lowers the minimum creep rate of steel provided that substantial recovery does not take place and the creep temperature does not exceed the recrystallization temperature for the particular degree of cold work. As shown in Figure 3.044, the introduction of 14 percent cold work improves the creep strength of Type 314 at 1650 F at creep rates faster than 10^{-3} percent per hour and at 1740 F at creep rates faster than 10^{-2} percent per hour. These improvements are attributed to an increase in the density of "free" dislocations, i.e., those not comprising subgrain boundaries. The increase in free dislocation density is temporary since dislocations are annealed out at long times and high temperatures. The creep rates then approximate those of the unpredeformed alloy. Sigma phase also precipitates during creep but does not affect the creep rate (8).	3	AMS 5652D (October 15, 1980).
		4	"Elevated Temperature Properties of Stainless Steels", ASTM S. T. P. No. 124 (January 1952).
		5	"Physical and Mechanical Properties of Some High-Strength Fine Wires", DMIC Memo 80 (January 20, 1961).
		6	Crucible Steel Co. of America, "Crucible 314 Stainless Steel", Data Sheet, 4th Revision (February 1959).
		7	Wyman-Gordon Co., "Forging Temperature for Stainless Steels and High Temperature Alloys", Data Sheets (January 19, 1959).
		8	Alloy Digest, "AISI Type 314", Filing Code: SS-100, Stainless Steel (February 1960).
		9	Adelus, J. L., and Guttman, V., "Effect of Prior Cold Working on the Creep of 314 Alloy Steel", <i>Materials Science and Engineering</i> , Vol. 44, No. 2 (July 1980), pp 195-204.
3.044	Effect of prior cold work on creep properties of Type 314 at elevated temperatures, Figure 3.044 [(a) 1650 F and (b) 1740 F].		Harrison, J. M., Norton, J. F., Derricott, R., and Marriott, J. B., "The Gaseous Carburisation of Austenitic Stainless Steels", <i>Materials and Corrosion</i> , Vol. 30, No. 11 (November 1979), pp 785-794.

AMS	Form	Military
5652D	Bar, forgings, flash welded rings, mechanical tubing	—
5522D	Plate, sheet, strip	—

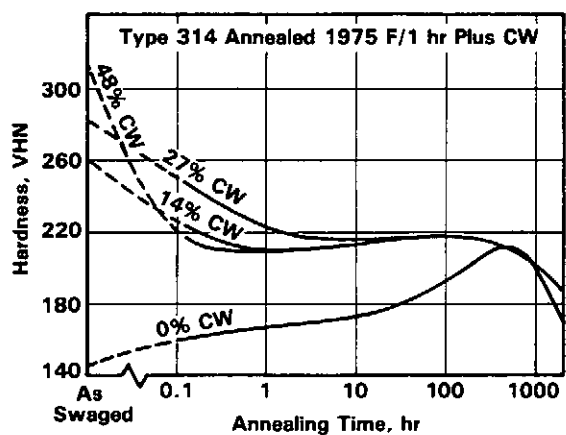
TABLE 1.031. SPECIFICATIONS

Specification	Type 314			
	AMS 5522D		AMS 5652D	
	Percent		Percent	
Element	Min	Max	Min	Max
Chromium	23.00	25.00	23.00	25.00
Nickel	19.00	22.00	19.00	22.00
Silicon	1.70	2.30	1.50	2.30
Manganese	1.00	2.00	1.00	2.00
Molybdenum	—	0.75	—	0.75
Copper	—	0.50	—	0.50
Carbon	—	0.12	—	0.18
Phosphorus	—	0.040	—	0.040
Sulfur	—	0.030	—	0.030

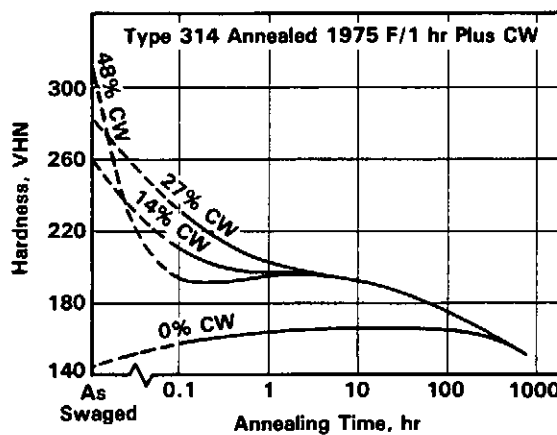
Fe
25 Cr
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TABLE 1.041. COMPOSITION (1, 2)



(a) 1650 F



(b) 1740 F

FIGURE 1.063. ROOM TEMPERATURE HARDNESS OF COLD WORKED AND ANNEALED ALLOY (8)

Alloy	Type 314
Temp, F	Btu/ft/hr ft ² F
212	10.1
932	12.1

TABLE 2.013. THERMAL CONDUCTIVITY (7)

Fe
25 Cr
20 Ni
2 Si

Type 314

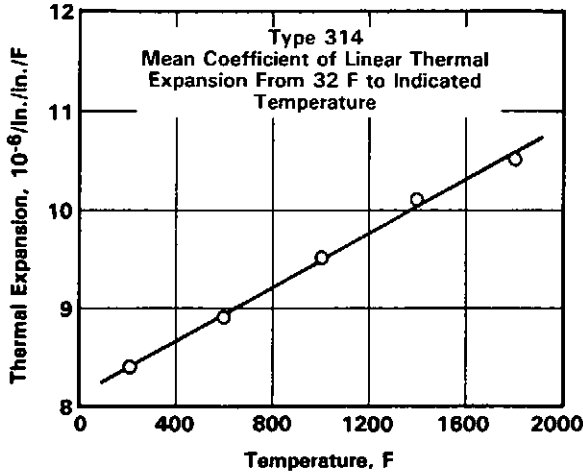


FIGURE 2.014. THERMAL EXPANSION (3)

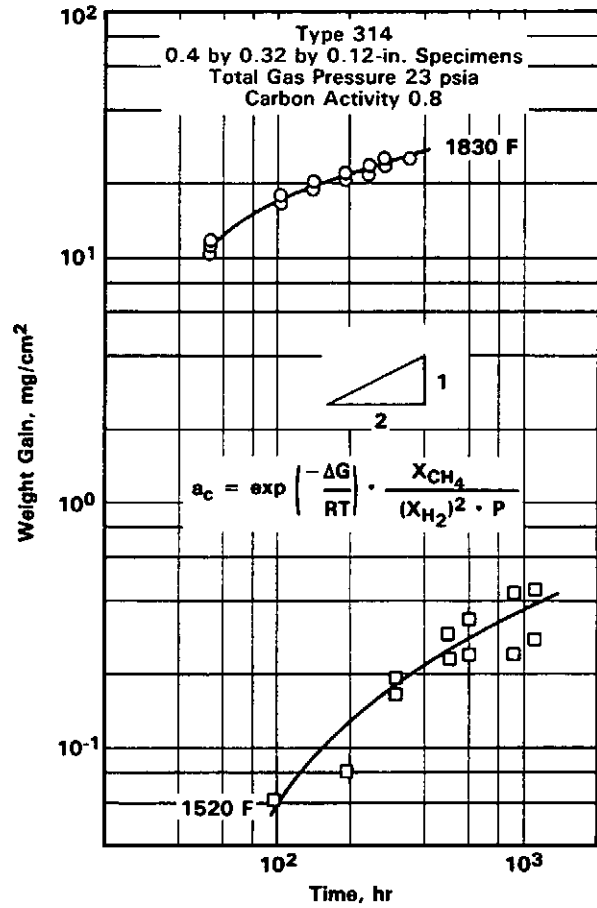


FIGURE 2.032. CARBURIZATION WEIGHT GAIN OF TYPE 314 IN HYDROGEN-METHANE GAS AT ELEVATED TEMPERATURES (9)

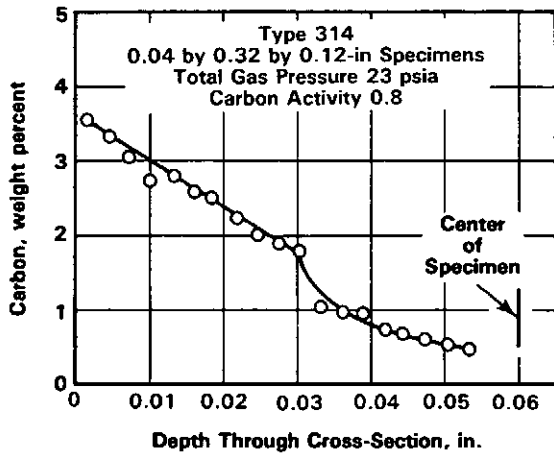


FIGURE 2.033. CARBON CONCENTRATION PROFILE THROUGH THICKNESS OF SPECIMEN AFTER EXPOSURE TO HYDROGEN-METHANE GAS MIXTURE FOR 100 HOURS AT 1830 F (9)

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Type 314									
AMS Spec	Product Form	Metallurgical Condition ^(a)	Thickness, in.	F _{tu} , ksi, Max	Hardness		Bending		
					Min	Max	Type of Bend	Angle, deg, Min	Bend Factor
5522D	Sheet, Strip Plate	CR, SHT HR, SHT	All	—	70 HRB	90 HRB	—	—	—
			≤ 0.249	—	—	—	Free bend	180	1
			≤ 0.249	—	—	—	V-block	135	1
			> 0.249, ≤ 0.749	—	—	—	Free bend	90	1
			> 0.249, ≤ 0.749	—	—	—	V-block	135	2
5652D	Bars	SHT, CF	≤ 2.75 dia	—	—	229 BHN	—	—	—
	Bars	SHT, HF	> 2.75 dia	—	—	187 BHN	—	—	—
	Forgings	Not Spec.	—	—	—	187 BHN	—	—	—
	Mechanical Tubing	SHT, CF	—	—	—	90 HRB	—	—	—
	Wire	SHT, CF	—	125 ^(b)	—	—	—	—	—

Note: The original AMS documents should be consulted for complete specification details.

(a) SHT = solution heat treated; CR = cold rolled; HR = hot rolled; CF = cold finished; HF = hot finished.

(b) Specified tensile strength or equivalent hardness.

TABLE 3.011. AMS SPECIFIED MECHANICAL PROPERTIES AT ROOM TEMPERATURE (1, 2)

Alloy	Type 314				
	Bar	Plate	Sheet	Wire	
Condition	Ann			Hard Drawn	
Thickness, in.	1 Dia			0.002 to 0.010	0.002 to 0.010
F _{tu} , ksi	100	100	100	95 to 130	245 to 275
F _{ty} , ksi	50	50	50	35 to 70	230 to 260
e (2 in.), percent	45	45	40	60 Max	1 to 2
RA, percent	60	60	—	—	—
Hardness, HRB	89	89	85	—	—

TABLE 3.0211. TYPICAL MECHANICAL PROPERTIES FOR BAR, PLATE, SHEET, AND WIRE (4, 5)

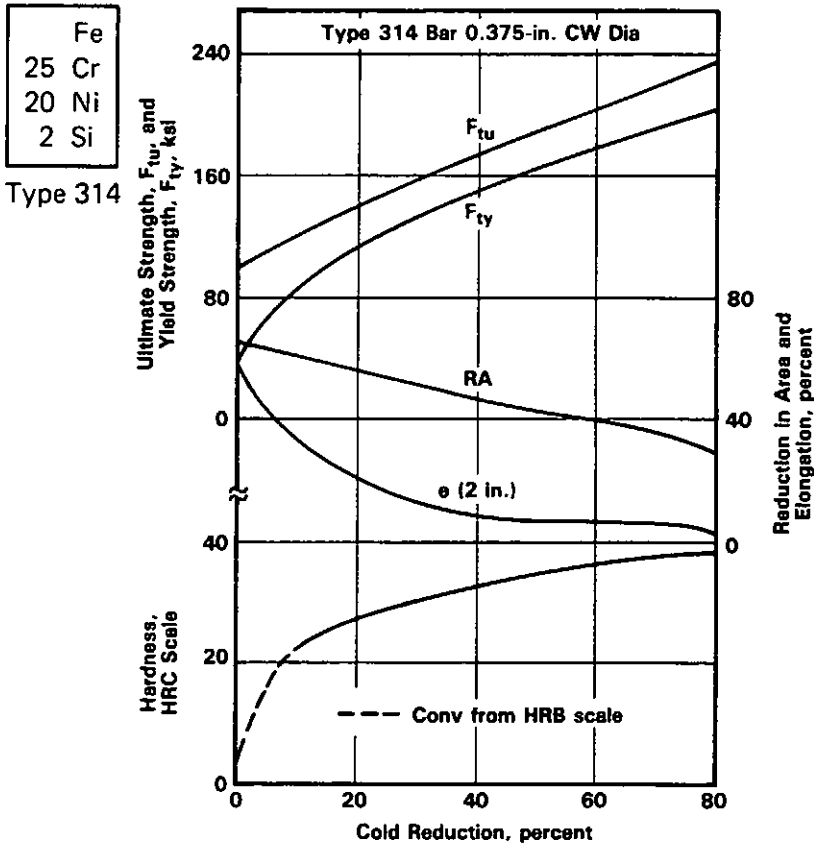


FIGURE 3.0212. EFFECT OF COLD WORK ON ROOM TEMPERATURE PROPERTIES OF BAR (5)

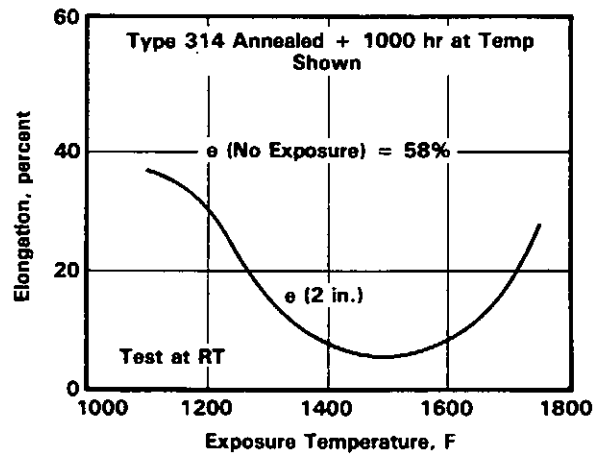


FIGURE 3.0213. EFFECT OF LONG-TIME EXPOSURE AT ELEVATED TEMPERATURES ON ROOM TEMPERATURE ELONGATION OF ANNEALED ALLOY (5)

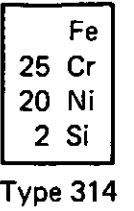
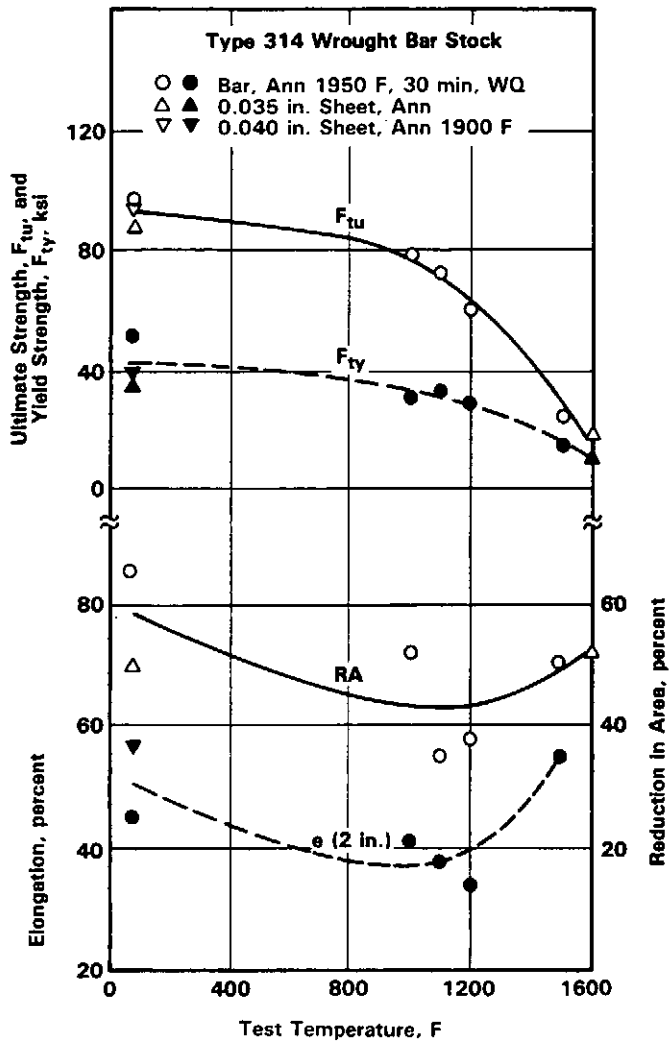


FIGURE 3.0311. SHORT-TIME TENSION PROPERTIES OF ANNEALED BAR AND SHEET AT ELEVATED TEMPERATURES (3)

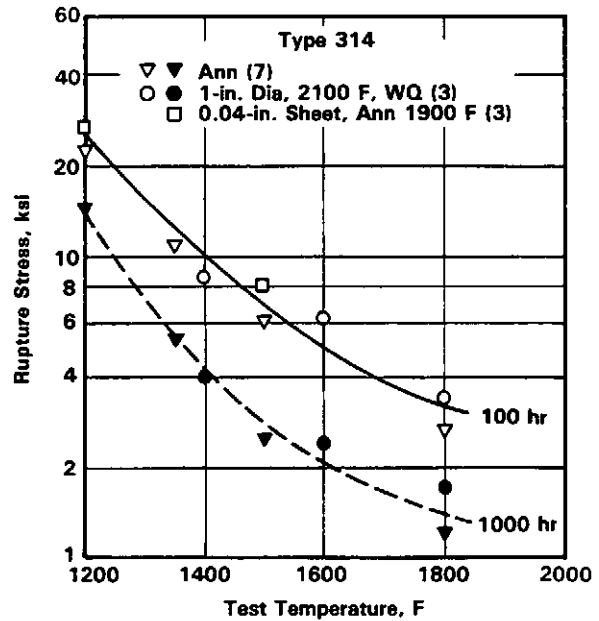


FIGURE 3.041. CREEP RUPTURE STRENGTH AT 1200 TO 1800 F (3, 7)

Fe
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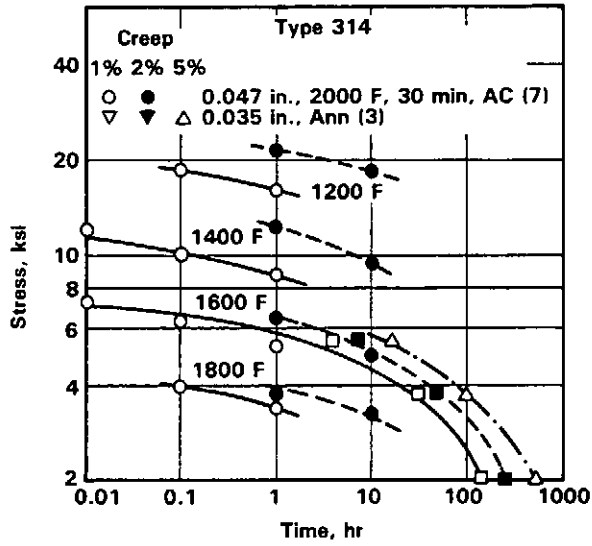
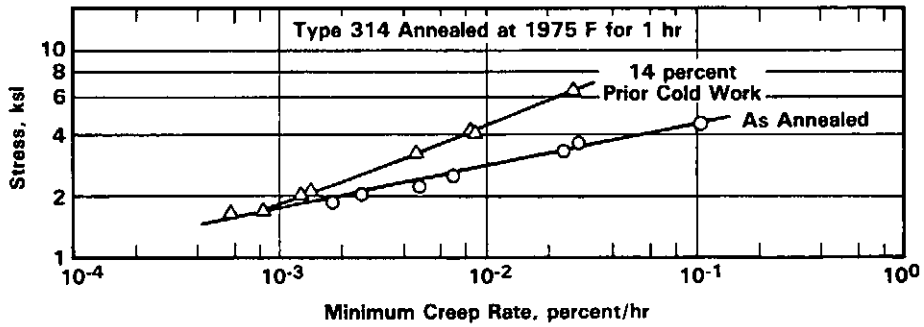
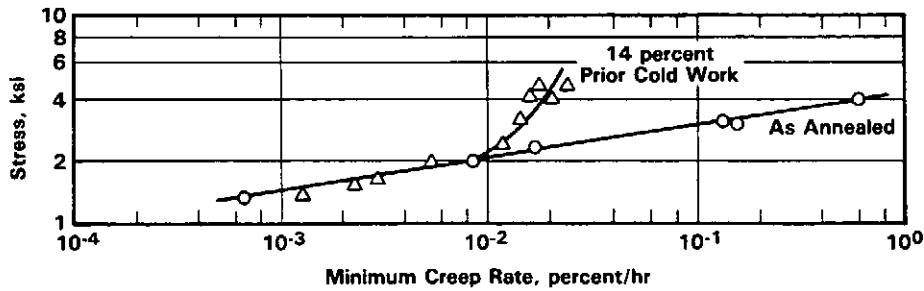


FIGURE 3.042. CREEP CURVES FOR ANNEALED SHEET AT 1200 TO 1800 F (3, 7)



(a) 1650 F



(b) 1740 F

FIGURE 3.044. EFFECT OF PRIOR COLD WORK ON CREEP PROPERTIES OF TYPE 314 AT ELEVATED TEMPERATURES (8)