

INCOLOY® alloy 330 (UNS N08330/W. Nr. 1.4886) is an austenitic alloy with good high-temperature strength and corrosion resistance. It has a solid solution composition and is not hardenable by heat treatment. Its high nickel and chromium provide good resistance to oxidation and carburization. Its oxidation resistance is enhanced by the silicon content.

The alloy's strength and oxidation resistance at elevated temperatures make it a useful material for industrial heating furnaces; for muffles, retorts, conveyor systems, baskets and boxes, and various fixtures.

### Physical Properties

Density, lb/in <sup>3</sup> .....	0.292
g/cm <sup>3</sup> .....	8.08
Melting Range, °F .....	2520-2590
°C .....	1380-1420
Specific Heat (32-212°F), Btu•lb•°F.....	0.11
(0-100°C), J/kg•°C .....	460
Poisson's Ratio at 70°F (20°C) .....	0.340
Permeability at 70°F (20°C) & 200 oersteds (15.9 kA/m) ....	1.02

### Limiting Chemical Composition, %

Nickel .....	34.0-37.0
Chromium.....	17.0-20.0
Iron .....	Balance*
Carbon.....	0.08 max.
Silicon.....	0.75-1.50
Manganese.....	2.0 max.
Phosphorus .....	0.030 max.
Sulfur .....	0.030 max.

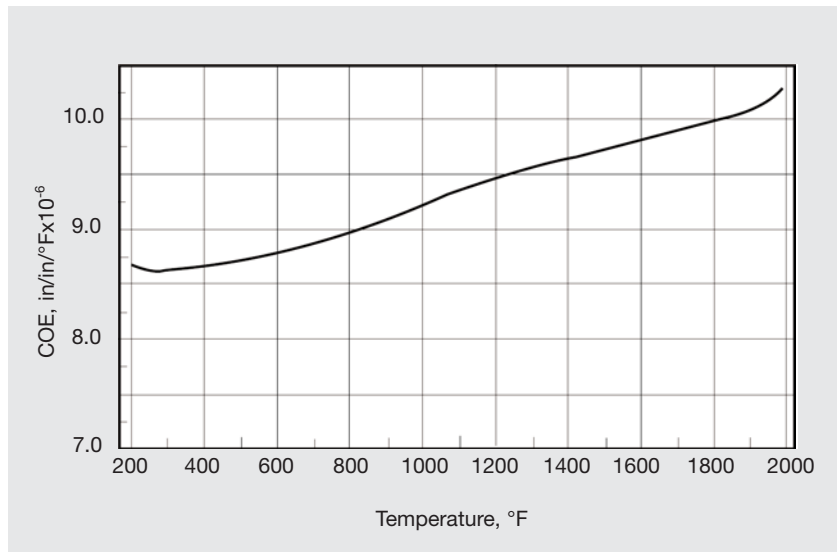
\*Reference to the 'balance' of a composition does not guarantee this is exclusively of the element mentioned but that it predominates and others are present only in minimal quantities.

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Coefficient of expansion data.

**INCOLOY® alloy 330**



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## Thermal and Electrical Properties

Temperature		Thermal Conductivity		Electrical Resistivity	
°F	°C	Btu-in/ft <sup>2</sup> -h-°F	W/m-°C	ohm-circ mil/ft	μΩ-m
75	24	86	12.4	612	1.017
400	204	108	15.6	649	1.079
800	427	134	19.3	688	1.144
1200	649	162	23.4	721	1.199
1600	871	198	28.6	744	1.237
1800	982	216	31.2	749	1.245

## Modulus of Elasticity

Temperature		Tensile Modulus	
°F	°C	10 <sup>3</sup> ksi	GPa
70	20	28.5	197
1600	870	19.5	134
1800	980	18.0	124

## Room Temperature Mechanical Properties

Form and Condition	Tensile Strength		Yield Strength (0.2% Offset)		Elongation
	ksi	MPa	ksi	MPa	%
Plate, hot-rolled & annealed	80-85	552-586	30-43	207-296	40-45
Sheet, cold-rolled & annealed	80-90	552-621	32-42	221-290	35-45
Rod, hot-finished & annealed	80-90	552-621	35-45	241-310	38-45

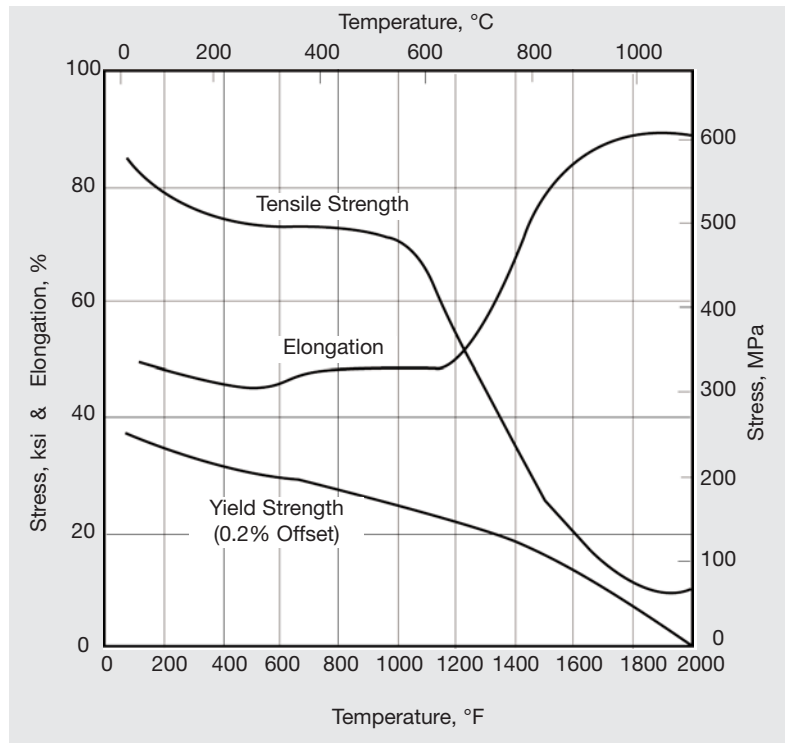
Values are composites for various product sizes and are not suitable for specification purposes.

### Impact Strength

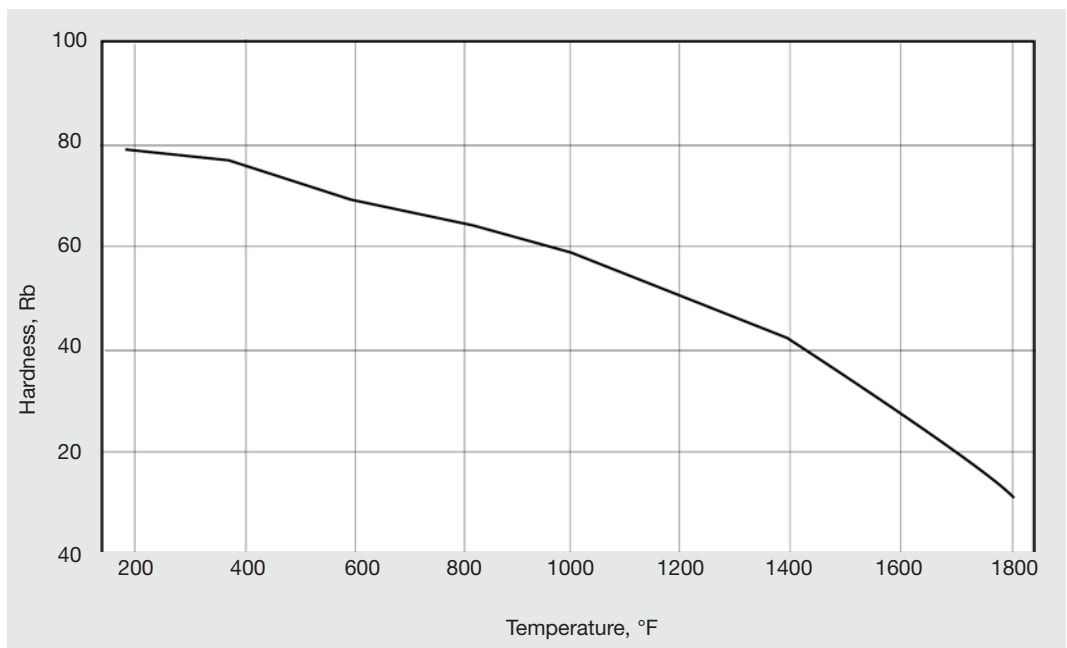
Material Condition	Test Temperature		Charpy V-Notch Impact Strength	
	°F	°C	ft-lbf	J
Annealed	75	25	>240	>325
	1400	760	167	226
Exposed to 1400°F (760°C) for 1000 h	75	25	96	130
	1400	760	130	176

## High Temperature Mechanical Properties

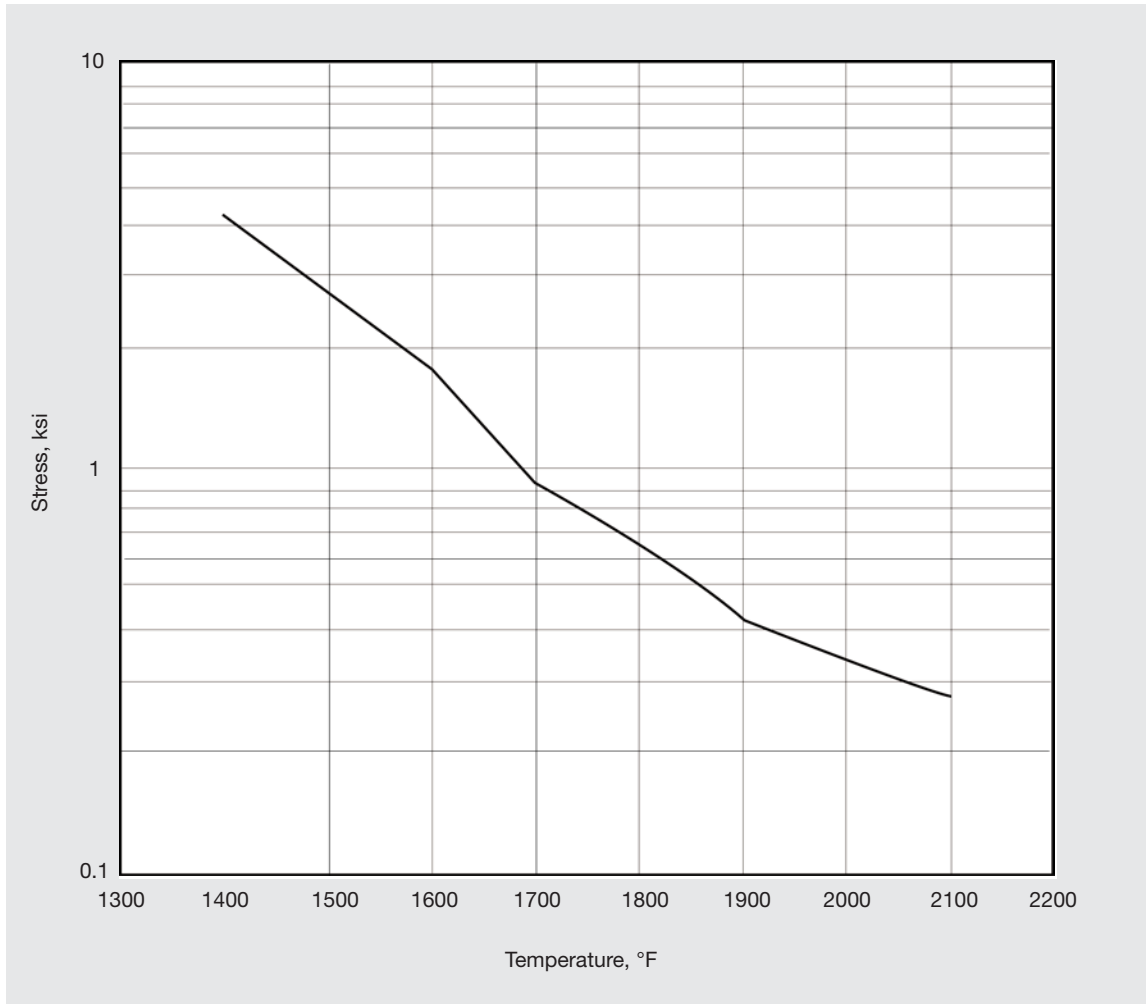
Tensile Properties of Annealed Material



Hardness at Elevated Temperature

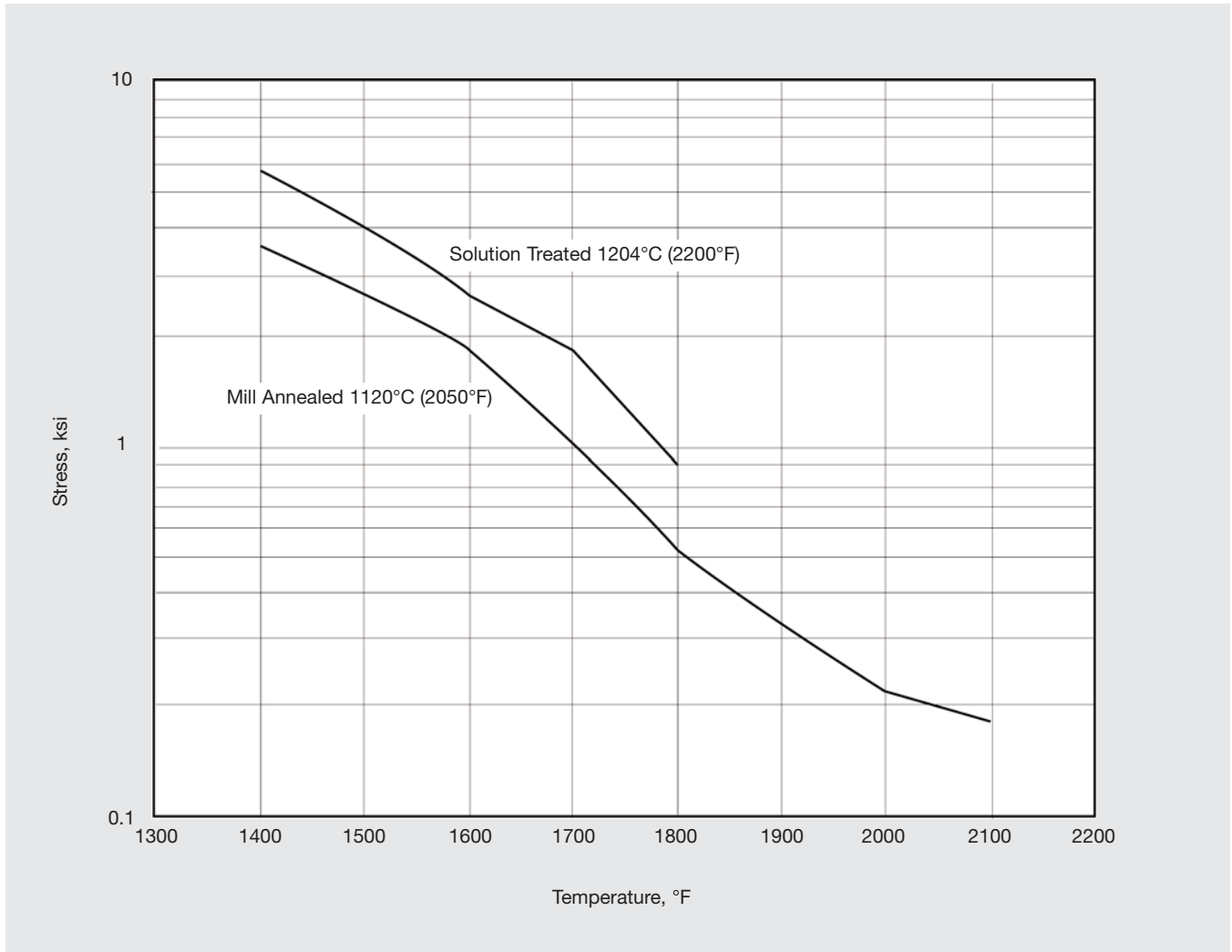


High Temperature Mechanical Properties (continued)



Stress to produce rupture in 10,000 hours (Mill Annealed 1120°C/2050°F)

High Temperature Mechanical Properties (continued)

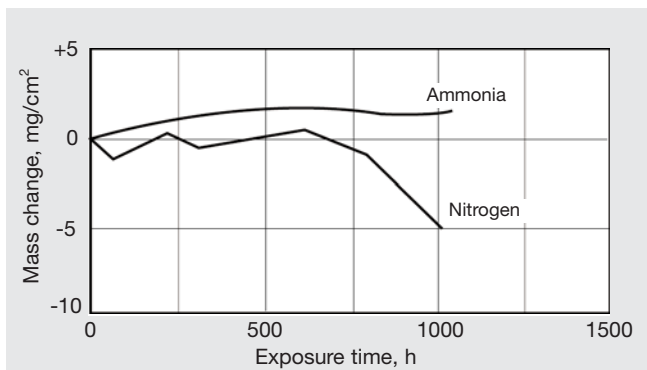


Stress to produce 0.0001%/hr secondary creep rate

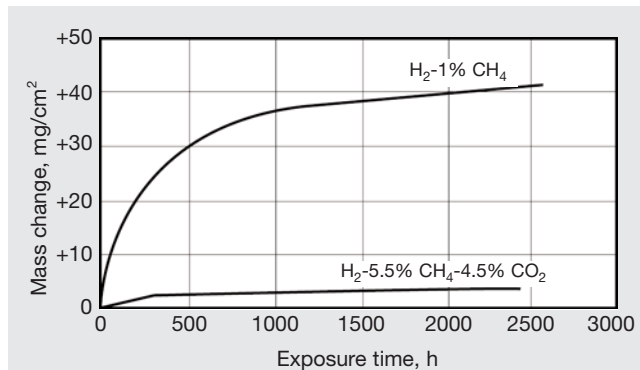
## INCOLOY® alloy 330

### Corrosion Resistance

INCOLOY® alloy 330 offers a high level of corrosion resistance, particularly to oxidation, carburization and nitridation. In aqueous environments, the alloy's chromium content provides resistance to oxidizing conditions while its nickel content imparts resistance to reducing conditions. The high nickel also gives INCOLOY alloy 330 good resistance to chloride-ion stress-corrosion cracking.



Mass change in ammonia and nitrogen at 2000°F (1093°C).



Mass change H<sub>2</sub>-5.5% CH<sub>4</sub>-4.5% CO<sub>2</sub> and H<sub>2</sub>-1% CH<sub>4</sub> at 1832°F (1000°C).

#### Resistance to Oxidation (non-adjusted laboratory air)

Temperature		Mass Change (mg/cm <sup>2</sup> ) in				
°F	°C	200 h	500 h	1000 h	1500 h	2000 h
1600	871	+0.24	-0.10	-0.37	-0.44	-0.89
1800	982	+1.58	+1.51	-0.44	-1.76	-3.32
2000	1093	+0.14	-0.39	-43.48	-	-

#### Laboratory test results in a range of media

Environment, Temperature & Time	Mass Change (mg/cm <sup>2</sup> ) in		Metal Loss	Max. Attack
	Underscaled	Descaled	microns	microns
Air-2% SO <sub>2</sub> -5% H <sub>2</sub> O 700°C (1292°F), 1000 h	+0.27	-0.15	-	-
Air-2% SO <sub>2</sub> -5% H <sub>2</sub> O 850°C (1562°F), 1000 h	-1.23	-3.20	0.00	55.88
Air-2% SO <sub>2</sub> -5% H <sub>2</sub> O 1000°C (1832°F), 1000 h	-2.03	-7.35	-	236.2
Air-5% H <sub>2</sub> O Vapor Isothermal 1000°C (1832°F), 1000 h	+2.49	-7.69	-	-
Air-10% H <sub>2</sub> O, 2 h cycles 1093°C (2000°F), 102 h	-26.49	-34.28	27.94	78.74
Air-10% H <sub>2</sub> O, 2 h cycles 982°C (1800°F), 102 h	-0.35	-2.91	-	-
Air-10% H <sub>2</sub> O, 2 h cycles 816°C (1500°F), 102 h	+0.08	-0.11	0.00	0.00
Air-5% H <sub>2</sub> O Vapor Isothermal 1177°C (2150°F), 1000 h	-180.5	-	254	371
N <sub>2</sub> -5% H <sub>2</sub> Isothermal 1177°C (2150°F), 1000 h	2.81	-	2.54	256

## Welding

INCOLOY alloy 330 is weldable by conventional processes. Shielded-metal-arc welding should be done with INCO-WELD A welding electrode; gas-shielded-arc welding with INCONEL filler metal 82. Acceptable welds have been made in relatively heavy sections with these welding products. For additional strength and corrosion resistance up to 2100°F (1150°C), INCONEL filler metal 617 and INCONEL welding electrode 117 may be used.

## Fabrication

INCOLOY alloy 330 is readily hot- or cold-formed using standard procedures for stainless steels and nickel alloys. The range for hot forming is 1750 to 2100°F (954 to 1149°C).

## Machining

Machining of INCOLOY alloy 330 requires more power than similar operations on mild steel and should be performed by techniques that minimize work hardening.

## Available Products and Specifications

INCOLOY alloy 330 is designated as UNS N08330 and W. Nr. 1.4886. Standard product forms include tube, sheet, strip, plate, round bar, forging stock, hexagon, wire and wire rod.

**Bars and shapes** - ASTM B 511, ASME SB 511

**Billets and bars** - ASTM B 512, ASME SB 512

**Pipe and tube** - ASTM B 535/ASME SB 535, ASTM B 546/ASME SB 546, ASTM B 710/ASME SB 710, ASTM B 739/ASME SB 739, ASTM B 829/ASME SB 829

**Plate, sheet and strip** - ASTM B 536, ASME SB 536, SAE AMS 5592

**Bars, wire, forgings and rings** - SAE AMS 5716

**Other** - ASTM B 366/ASME SB 366



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