

# Alloy 718

UNS N07718

**Alloy 718 (UNS N07718)** is an age-hardenable alloy that is highly corrosion resistant. Its high strength, corrosion resistance, and ease of weld fabrication have made Alloy 718 the most popular superalloy used in industry.

## Specification

NiWire follows: ASTM B 637 (rod, bar, forgings, and forging stock), B 670 (plate, sheet, and strip) AMS 5589 (seamless tubing), 5590 (seamless tubing), 5596 (sheet, strip, and plate), 5597 (sheet, strip, and plate), 5662 (bars, forgings, and rings), 5663 (bars, forgings, and rings), 5664 (bars, forgings, and rings) NACE MR0175

## Chemical Composition

*Composition limits:* 50.0 to 55.0 min Ni + Co; 17.0 to 21.0 Cr; 4.75 to 5.50 Nb; 2.80 to 3.30 Mo; 0.65 to 1.15 Ti; 0.20 to 0.80 Al; 1.00 max Co; 0.08 max C; 0.35 max Mn; 0.35 max Si; 0.015 P; 0.015 S; 0.006 max B; 0.30 max Cu; bal Fe

## Applications

*Typical uses:* Age-hardenable Alloy 718 combines high-temperature strength up to 700 °C (1300 °F) with corrosion resistance and excellent fabricability. Its welding characteristics, especially its resistance to postweld cracking, are outstanding. Because of these attributes, Alloy 718 is used for parts for aircraft turbine engines; high-speed airframe parts, such as wheels, buckets, and spacers; high-temperature bolts and fasteners, cryogenic tankage, and components for oil and gas extraction and nuclear engineering.

## Physical Properties

*Density:* 8.19 g/cm<sup>3</sup> (0.296 lb/in.<sup>3</sup>)

*Melting range:* 1260 to 1336 °C (2300–2437 °F)

*Specific heat:* 435 J/kg · K (0.104 Btu/lb · °F)

*Thermal conductivity:* For annealed and aged bar: 11.4 W/m · K (79 Btu/ft<sup>2</sup> · in. · h · °F) at 21 °C (70 °F)

*Electrical resistivity:* For annealed and aged bar: 1218 nΩ · m (733 Ω circular-mil/ft)

*Magnetic permeability:* For annealed and aged material: 1.0011 at room temperature

*Curie temperature:* For annealed and aged material: –112 °C (–170 °F)

Coefficient of thermal expansion (linear):

Temperature		Average coefficient(a)(b)	
°C	°F	μm/m · K	μin./in. · °F
–195	–320	10.6	5.9
95	200	13.2	7.31
205	400	13.6	7.53
315	600	13.9	7.74
425	800	14.3	7.97
540	1000	14.6	8.09
650	1200	15.1	8.39
760	1400	16.0	8.91

(a) From 20 °C (70 °F) to temperature shown. (b) Values for annealed and aged material

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## Mechanical Properties

Room-temperature tensile properties of hot-rolled Alloy 718 bar:

Dia. (a)		Heat treatment(b)	Tensile strength		Yield strength (0.2% offset)		Elongation %	Reduction %	Hardness
mm	in.		MPa	psi	Mpa	psi			
16	5/8	As-rolled	965	140000	591	85700	46	58	23 HRC
		955 °C (1750 °F)/1 h	965	140000	572	83000	45	49	99 HRB
		1065 °C (1950 °F)/1 h	810	117500	334	48500	58	64	85 HRB
		955 °C (1750 °F)/1 h, age	1434	208000	1241	180000	21	39	46 HRC
		1065 °C (1950 °F)/1 h, age	1338	194000	1083	157000	23	34	45 HRC
25	1	As-rolled	896	130000	448	65000	54	67	16 HRC
		955 °C (1750 °F)/1 h	889	129000	445	64500	55	61	94 HRB
		1065 °C (1950 °F)/1 h	776	112500	359	52000	64	68	87 HRB
		955 °C (1750 °F)/1 h, age	1389	201500	1207	175000	20	36	46 HRC
		1065 °C (1950 °F)/1 h, age	1296	188000	1048	152000	21	34	45 HRC
38	3/2	As-rolled	1014	147000	727	105500	40	52	32 HRC
		955 °C (1750 °F)/1 h	976	141500	500	72500	46	45	97 HRB
		1065 °C (1950 °F)/1 h	827	120000	379	55000	58	60	89 HRB
		955 °C (1750 °F)/1 h, age	1413	205000	1155	167500	20	28	46 HRC
		1065 °C (1950 °F)/1 h, age	1317	191000	1055	153000	24	36	43 HRC
100	4	955 °C (1750 °F)/1 h	810	117500	379	55000	53	52	90 HRB
		1065 °C (1950 °F)/1 h	776	112500	331	48000	60	63	87 HRB
		955 °C (1750 °F)/1 h, age	1324	192000	1138	165000	17	24	46 HRC
		1065 °C (1950 °F)/1 h, age	1348	195500	1138	165000	21	34	43 HRC

(a) Five separate heats represented. All tests are longitudinal. (b) When annealing is at 955 °C (1750 °F), aging is 720 °C (1325 °F) for 8 h, furnace cool to 625 °C (1150 °F) hold at 625 °C (1150 °F) for total aging time of 18 h.

When annealing is at 1065 °C (1950 °F), aging is 760 °C (1400 °F) for 10 h, furnace cool to 650 °C (1200 °F), hold at 650 °C (1200 °F) for total aging time of 20 h

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Room-temperature tensile properties of Alloy 718 cold-rolled sheet, annealed and aged in accordance with AMS 5597A:

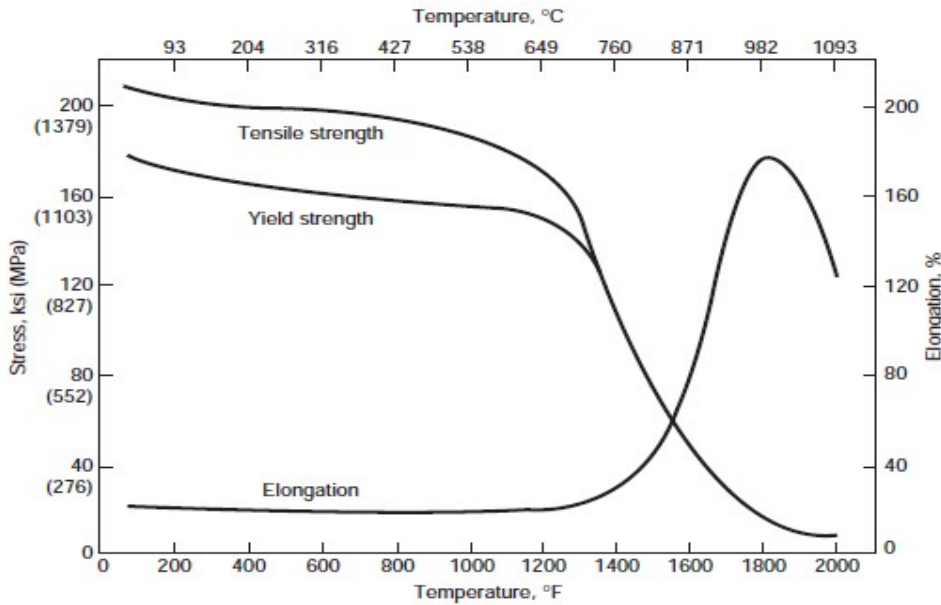
Thickness		Tensile strength		Yield strength		Elongation
mm	in.	MPa	psi	MPa	psi	%
0.25	0.010	1,327	192,500	1,189	172,500	17
0.30	0.012	1,407	204,000	1,169	169,500	19
0.38	0.015	1,365	198,000	1,117	162,000	19
0.41	0.016	1,351	196,000	1,127	163,500	19
0.46	0.018	1,355	196,500	1,072	155,500	21
0.53	0.021	1,396	202,500	1,165	169,000	20
0.64	0.025	1,372	199,000	1,120	162,500	20
0.79	0.031	1,358	197,000	1,103	160,000	21
1.02	0.040	1,434	208,000	1,186	172,000	16
1.19	0.047	1,372	199,000	1,148	166,500	20
1.27	0.050	1,455	211,000	1,220	177,000	16
1.57	0.062	1,403	203,500	1,179	171,000	18
1.98	0.078	1,324	192,000	1,093	158,500	17
2.03	0.080	1,379	200,000	1,127	163,500	20
2.36	0.093	1,372	199,000	1,151	167,000	19
2.54	0.100	1,434	208,000	1,214	176,000	18
2.77	0.109	1,407	204,000	1,179	171,000	19
3.18	0.125	1,403	203,500	1,186	172,000	16
3.96	0.156	1,355	196,500	1,110	161,000	21
4.75	0.187	1,431	207,500	1,255	182,000	18
5.33	0.210	1,341	194,500	1,103	160,000	22
6.35	0.250	1,413	205,000	1,176	170,500	19

Modulus of elasticity of hot-rolled, annealed, and aged Alloy 718 flat product:

Temperature		Elastic modulus		Torsional modulus		Poisson's ratio
°C	°F	GPa	psi × 106	GPa	psi × 106	
20	70	200	29.0	77	11.2	0.294
40	100	199	28.8	77	11.2	0.291
95	200	196	28.4	76	11.0	0.288
150	300	193	28.0	75	10.9	0.280
260	500	187	27.1	73	10.6	0.275
370	700	181	26.2	71	10.3	0.273
480	900	174	25.3	68	9.9	0.272
595	1100	167	24.2	65	9.5	0.276
705	1300	159	23.0	61	8.9	0.292
815	1500	147	21.3	56	8.1	0.321
980	1800	120	17.4	45	6.5	0.341
1095	2000	98.6	14.3	35	5.1	0.402

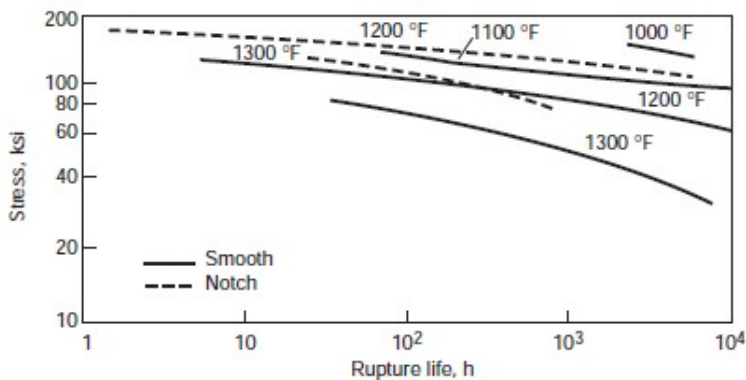
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Elevated-temperature tensile properties of hot-rolled, annealed, and aged 13mm dia Alloy 718 bar:

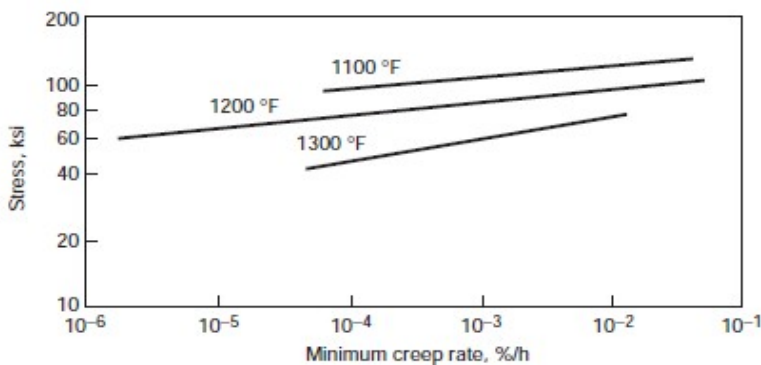


## Chemical Properties

General corrosion behavior: Good to excellent resistance to organic acids, alkalis and salts, and seawater. Fair resistance to sulfuric, hydrochloric, hydrofluoric, phosphoric, and nitric acids. Good to excellent resistance to oxidation, carburization, nitridation, and molten salts. Fair resistance to sulfidation



Smooth and notch stress-rupture life of hot-rolled Alloy 718 bar, 16 mm (5/8 in.) dia, that was annealed at 980 °C (1800 ° F) for 1 h, water quenched and aged at 720 °C (1325 °F) for 8 h, furnace cooled to 620 °C (1150 °F), and held at 620 °C (1150 °F) for a total aging time of 18 h. Stress concentration factor,  $K_t = 4$



Creep strength of hot-rolled Alloy 718 bar, 16 mm (5/8 in.) dia, that was heat treated the same manner as in above figure