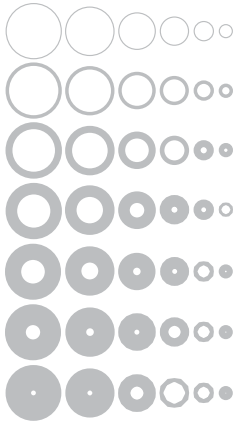


ALLOY 718 Data Memorandum No. 33



Introduction

One of the distinguishing features of this nickel-chromium-iron-molybdenum alloy's composition is the addition of niobium (columbium) to permit age-hardening. It is thus set apart from popular nickel-chromium alloys which are age-hardened through the addition of aluminum and titanium.

Super Alloy

Alloy 718 is one of a number of Super Alloy materials that Superior Tube offers in small diameter, precision tubing. This material meets Superior Tube's definition of a super alloy: "Super Alloys are metals which have 1,000 hr, stress rupture strength at 1,200°F at 25,000 psi minimum stress in combination with resistance to progressive scaling (oxidation) and other types of corrosion."

Specific characteristics of this material include:

- Good ductility is evidenced at 1,200°F to 1,400°F.
- Yield tensile strength, creep, and rupture strength properties are exceedingly high at temperatures up to 1,300°F.
- The unique property of slow aging response permits heating and cooling during annealing without the danger of cracking. Problems associated with welding of age-hardenable alloys are eliminated with Alloy 718.
- Fracture toughness tests have been conducted on the alloy in forms other than tubing at temperatures from -320°F to 1,000°F with excellent values reported.
- Good weldability is achieved using inert-arc techniques.

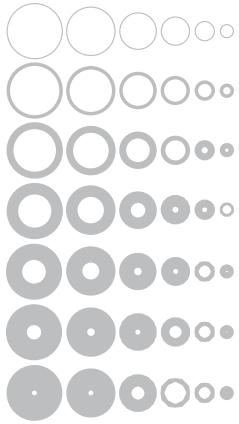
Chemical Composition

Nickel	50.0-55.0%	Silicon	0.350% max
Chromium	17.0-21.0%	Manganese	0.350% max
Niobium + Tantalum	4.75-5.50%	Sulfur	0.015% max
Molybdenum	2.80-3.30%	Copper	0.300% max
Aluminum	0.20-0.80%	Phosphorus	0.015% max
Titanium	0.65-1.15%	Cobalt	1.00% max.
Carbon	0.08% max	Iron	Balance

Physical Properties

Density.....	Annealed – 0.296 lb/in ³ Age hardened – 0.297 lb/in ³
Modulus of Elasticity.....	29.0 x 10 ⁶ psi @ 70°F

ALLOY 718



Dimensional Stability

The alloy contracts slightly during the aging process, the linear contraction being about 0.05%.

Mechanical Properties

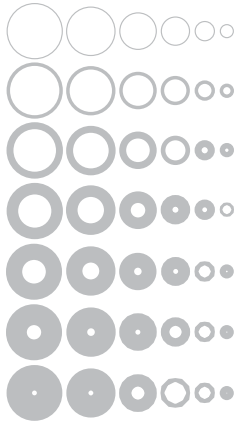
Temper	Ultimate Tensile Strength x 103 psi	Yield Strength 0.2% offset x 103 psi	% Elongation In 2"	Rockwell Hardness
#1	155 max	40/95	30 min	C 25 max
#2	140/190	90/150	7 min	C 28/38
#3	80/220	140/190	3 min	C 35/45

**Applicable to sizes 0.125 in (3.18 mm) OD and larger x 0.015 in (0.38 mm) wall and heavier, tested at room temperature.*

Size Range

Alloy 718 is offered in seamless form within the following production limits:

Outside Diameter		Wall Capacity			
		Minimum		Maximum	
in	mm	in	mm	in	mm
0.0312	0.793	0.004	0.102	0.010	0.254
0.0625	1.588	0.004	0.102	0.025	0.635
0.0937	2.380	0.004	0.102	0.040	1.016
0.1250	3.175	0.004	0.102	0.049	1.245
0.1875	4.763	0.005	0.127	0.065	1.651
0.2500	6.350	0.005	0.127	0.078	1.981
0.3125	7.938	0.005	0.127	0.083	2.108
0.3750	9.525	0.005	0.127	0.109	2.769
0.4375	11.113	0.006	0.152	0.109	2.769
0.5000	12.700	0.006	0.152	0.109	2.769
0.5625	14.288	0.006	0.152	0.109	2.769
0.6250	15.875	0.006	0.152	0.109	2.769
0.7500	19.050	0.006	0.152	0.035	0.889
0.8750	22.225	0.020	0.508	0.035	0.889
1.0000	25.400	0.012	0.305	0.035	0.889



Tolerances

Round tubing is produced to the following commercial tolerances applicable to two dimensions only, for average OD-wall relationship. For complete tolerance data, request Data Memo No. 8.

Outside Diameter Range	Nominal Outside Diameter		Nominal Inside Diameter		Nominal Wall
	in	mm	in	mm	
Up to, but not including $\frac{3}{32}$ in (2.38 mm)	+ 0.002	+ 0.005	+ 0.000	+ 0.000	± 10%
	- 0.000	- 0.000	- 0.002	- 0.005	
$\frac{3}{32}$ in (2.38 mm) to, but not including $\frac{3}{16}$ in (4.76 mm)	+ 0.076	+ 0.003	+ 0.000	+ 0.000	± 10%
	- 0.000	- 0.000	- 0.003	- 0.076	
$\frac{3}{16}$ in (4.76 mm) to, but not including $\frac{1}{2}$ in (12.70 mm)	+ 0.004	+ 0.102	+ 0.000	+ 0.000	± 10%
	- 0.000	- 0.000	- 0.004	- 0.102	
$\frac{1}{2}$ in (12.70 mm) to, but not including $1\frac{1}{2}$ in (38.10 mm)	+ 0.005	+ 0.127	+ 0.000	+ 0.000	± 10%
	- 0.000	- 0.000	- 0.005	- 0.127	

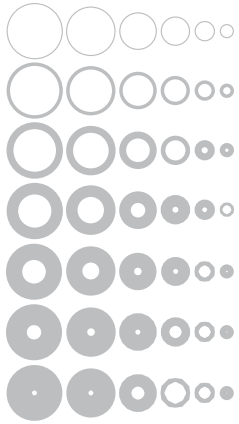
Heat Treatment Procedures

Annealing

Alloy 718 can be annealed between 1,700-1,950°F. Cooling rate should be rapid, but water quenching is not required. The higher annealing temperature is used for in-process anneals and when stress rupture properties are the most important. The lower annealing temperature range is used when aged mechanical properties are of primary concern.

Age Hardening

Since most customer applications require machining or other fabrication, Superior Tube does not generally supply Alloy 718 in the age-hardened condition. Recommended age-hardening treatment, as covered by AMS-5589, calls for heating to 1,325°F for 8 hours, furnace cooling to 1,150°F, and holding at 1,150°F for 10 hours, followed by air cooling. Best stress rupture properties are obtained if annealing is performed as outlined in the previous paragraph, and prior to age-hardening. For additional data, request Bulletin No. 72, Super Alloys.



Fabrication

Alloy 718 can be both welded and brazed. The tungsten arc inert gas (TIG) process should be used with good gas coverage and with joints clean and free of all contaminants. Filler metals tested to date have included Inconel-X-750, Alloy 718, and several of the cobalt base alloys.

Furnace brazing techniques have proven satisfactory. In a dry hydrogen atmosphere flux is not required. Tensile properties will drop if brazing temperatures exceed 1,800°F.

Machining in either the age-hardened or annealed condition can be accomplished. Tooling and procedure are similar to those used for other heat-treatable nickel-chrome alloys.

Availability

Alloy 718 may be ordered in production quantities in accordance with customer and/or industry standard specifications. For comparison with other high temperature strength and oxidation resistant materials in the Super Alloy family, request Bulletin No. 72.

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