Technical Datasheet

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Pyromet® Alloy 718

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Identification

UNS Number

- N07718

DIN Number

- 2.4668

Type Analysis

Carbon	0.08 %	**Manganese**	0.35 %
Phosphorus	0.015 %	**Sulfur**	0.015 %
Silicon	0.35 %	**Chromium**	17.00 to 21.00 %
Molybdenum	2.80 to 3.30 %	**Copper**	0.15 %
Cobalt	1.00 %	**Titanium**	0.65 to 1.15 %
Aluminum	0.35 to 0.80 %	**Columbium + Tantalum**	4.75 to 5.50 %
Boron	0.001 to 0.006 %	**Nickel + Cobalt**	50.00 to 55.00 %
Iron	11.30 to 22.50 %		

The Cobalt content is on an "If determined" basis.

General Information

Description

Pyromet® alloy 718 is a precipitation hardenable nickel-base alloy designed to display exceptionally high yield, tensile and creep-rupture properties at temperatures up to 1300°F (704°C). The sluggish age-hardening response of Pyromet alloy 718 permits annealing and welding without spontaneous hardening during heating and cooling. This alloy has excellent weldability when compared to the nickel-base superalloys hardened by aluminum and titanium.

Applications

This alloy has been used for jet engine and high-speed airframe parts such as wheels, buckets, spacers, and high temperature bolts and fasteners.

Corrosion Resistance

Important Note: *The following 4-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors which affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish and dissimilar metal contact.*

Nitric Acid	Good	Sulfuric Acid	Moderate
Phosphoric Acid	Moderate	Acetic Acid	Good
Sodium Hydroxide	Good	Salt Spray (NaCl)	Excellent
Sea Water	Moderate	Sour Oil/Gas	Good
Humidity	Excellent		

Properties

Physical Properties

Density

--	0.2970	lb/in³

Mean Coefficient of Thermal Expansion

77°F, 200°F	7.10	x 10^{-6} in/in/°F
77°F, 400°F	7.50	x 10^{-6} in/in/°F
77°F, 600°F	7.70	x 10^{-6} in/in/°F
77°F, 800°F	7.90	x 10^{-6} in/in/°F
77°F, 1000°F	8.00	x 10^{-6} in/in/°F
77°F, 1200°F	8.40	x 10^{-6} in/in/°F
77°F, 1400°F	8.90	x 10^{-6} in/in/°F

Coefficient of Thermal Expansion

Temperature Range		10^{-6}/°F	10^{-6}/°C
77°F to	25°C to		
200	93	7.1	12.8
400	204	7.5	13.5
600	316	7.7	13.9
800	427	7.9	14.2
1000	538	8.0	14.4
1200	649	8.4	15.1
1400	760	8.9	16.0

Modulus of Elasticity (E)

70°F	29.6 x 10^3 ksi
200°F	29.2 x 10^3 ksi
400°F	28.8 x 10^3 ksi
600°F	27.6 x 10^3 ksi
800°F	26.5 x 10^3 ksi
1000°F	25.5 x 10^3 ksi
1200°F	24.5 x 10^3 ksi
1400°F	23.1 x 10^3 ksi
1600°F	18.1 x 10^3 ksi
1750°F	11.1 x 10^3 ksi

Modulus of Elasticity (E)

Temperature		psi x 10^6	MPa x 10^3
°F	°C		
70	21	29.6	2.08
200	93	29.2	2.05
400	204	28.8	2.02
600	316	27.6	1.94
800	427	26.5	1.86
1000	538	25.5	1.79
1200	649	24.5	1.72
1400	760	23.1	1.62
1600	871	18.1	1.27
1750	954	11.1	0.78

Electrical Resistivity

70.0°F	728.0 ohm-cir-mil/ft

Melting Range

--	2200.000 to 2450.000 °F

Typical Mechanical Properties

Effect of Solution Treating Temperature on Transverse Room Temperature Properties – Pyromet Alloy 718

Tensile properties of a 4" (101.6 mm) square billet

Solution Treating Temperature		0.2% Yield Strength		Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area	Rockwell C Hardness	ASTM Grain Size
°F	°C	ksi	MPa	ksi	MPa				
1750	954	160.1	1104	183.7	1267	8.1	13.6	42	7
1900	1038	163.7	1129	183.7	1267	12.8	20.3	42	5/6
1950	1066	158.2	1091	180.9	1247	14.0	19.6	42	4/5
2000	1093	154.6	1066	178.0	1227	17.3	24.5	40	4/4.5
2050	1121	149.9	1033	171.1	1180	17.5	27.9	39	3.5/4

Note: All samples solution treated 2 hours at the temperature indicated and air cooled. Aging consisted of 8 hours at 1325°F (718°C), cooled 100°F/hr to 1150°F (56°C/hr to 621°C), held 8 hours at 1150°F (621°C), and air cooled.

Effect of Solution Treating Temperature on the Transverse Stress Rupture Properties – Pyromet Alloy 718

4" (101.6 mm) square billet

Solution Treating Temperature		Test Temperature		Stress		Rupture Life Hours	% Elongation in 2" (50.8 mm)	% Reduction of Area
°F	°C	°F	°C	ksi	MPa			
1750	954	1300	704	75	517	64.8	17.4	25.3
1900	1038	1300	704	75	517	132.1	9.4	17.2
1950	1066	1300	704	75	517	95.2	7.9	10.8
2000	1093	1300	704	75	517	141.0	2.5	6.8

Notes: All samples solution treated 2 hours at the temperatures indicated and air cooled. Aging consisted of 8 hours at 1325°F (718°C), cooled 100°F/hr to 1150°F (56°C/hr to 621°C), held 8 hours at 1150°F (621°C), and air cooled.

All specimens were combination smooth-notch bars with 0.178" (4.52 mm) gage diameter, 0.712" (18.1 mm) gage length and $K_t = 3.8$.

Stress rupture notch sensitivity may result from 1900°F (1038°C) solution treatment. This is due to reduction of precipitate at grain boundaries with this treatment.

Elevated Temperature Tensile Tests – Pyromet Alloy 718

½" (12.7 mm) bar stock

Test Temperature		0.2% Yield Strength		Tensile Strength		% Elongation 2" (50.8 mm)
°F	°C	ksi	MPa	ksi	MPa	
70	21	175	1207	210	1448	22.0
200	93	170	1172	204	1407	21.0
400	204	163	1124	198	1365	20.0
600	316	159	1096	195	1344	20.0
800	427	156	1076	191	1317	19.0
1000	538	155	1069	185	1276	18.0
1200	649	149	1027	168	1158	19.0
1400	760	110	758	110	758	27.0

Heat Treatment: 1 hr—1800°F (982°C), air cool + 8 hr—1325°F (718°C), cool 100°F/hr to 1150°F (56°C/hr to 621°C), hold 8 hr, air cool.

Low Temperature Tensile Data – Pyromet Alloy 718
Transverse tests—4" (101.6 mm) square billet

Test No.	Test Temperature		0.2% Yield Strength		Tensile Strength		% Elongation in 2" (50.8 mm)	% Reduction of Area
	°F	°C	ksi	MPa	ksi	MPa		
1	Room	Room	157	1082	183.8	1267	18.0	21.6
2	Room	Room	156	1076	181.3	1250	16.5	23.3
3	Room	Room	152.5	1051	179.5	1238	19.0	29.1
4	-423	-253	196.2	1353	250.4	1726	14.0	16.2
5	-423	-253	200	1379	244.2	1684	13.0	17.5
6	-423	-253	194.2	1339	241.9	1668	12.0	16.7

Heat Treatment: 2 hr—1950°F (1066°C), air cool +8 hr—1325°F (718°C), cool 100°F/hr to 1150°F (56°C/hr to 621°C), hold 8 hr, air cool.

Stress Rupture Data – Pyromet Alloy 718

Test Temperature		Stress for Rupture							
		100 Hours				1000 Hours			
		Smooth		Notch		Smooth		Notch	
°F	°C	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
1100	593	170	1172	220	1517	130	896	205	1413
1200	649	110	758	195	1344	85	586	170	1172
1300	704	75	517	130	896	55	379	80	552
1400	760	44	303	63	434	25	172	35	241

Heat Treatment: 1 hr—1800°F (982°C), air cool +8 hr—1325°F (718°C), furnace cool 100°F/hr to 1150°F (56°C/hr to 621°C), hold 8 hr, air cool.

Heat Treatment

The following heat treatment should be used to obtain the best combination of tensile properties and stress rupture properties:

1 hr 1750°F to 1800°F (954°C to 982°C) air cool + 8 hr 1325°F (718°C) cool 100°F/hr to 1150°F (56°C/hr to 621°C), hold 8 hr and air cool.

To obtain the best room temperature and cryogenic tensile properties, the following heat treatment should be used:

1 to 2 hr 1950°F (1066°C), air cool + 8 hr 1325°F (718°C) cool 100°F/hr to 1150°F (56°C/hr to 621 °C), hold 8 hr and air cool.

Workability

Hot Working

Hot working is carried out using a 2050°F (1121°C) maximum furnace temperature. Hot-cold working in the range 1700/1850°F (927/1010°C) will improve the strength of the forging if the service temperature is below about 1100°F (593°C). Prolonged soaking at the forging temperature is not desirable. The material should be given uniform reductions to avoid the formation of duplex grain structures.

Machinability

The alloy can be readily machined in either the annealed or the age-hardened condition. The age-hardened condition gives better chip action on chip breaker tools and produces a better finish. The annealed condition will give a slightly longer tool life. Tooling and procedures are similar to those used for Carpenter Pyromet alloy X-750.

Weldability

Pyromet alloy 718 can be welded in either the annealed or the aged condition. Welding in the aged condition will cause the formation of a softened heat-affected zone.

Other Information

Applicable Specifications

- AMS 5662
- AMS 5663

Forms Manufactured

- Bar-Rounds
- Bar-Shapes
- Billet
- Strip

- Wire
- Wire-Rod

Technical Articles

- A Designer's Manual On Specialty Alloys For Critical Automotive Components
- A Guide to Etching Specialty Alloys for Microstructural Evaluation
- Alloy Selection for Cold Forming (Part I)
- Alloy Selection for Cold Forming (Part II)
- Forging Difficult Alloys: How to Get Better Results, Consistently
- How to Select the Right Stainless Steel or High Temperature Alloy for Heading
- New Requirements for Ferrous-Base Aerospace Alloys
- Selecting High Temperature Alloys for Fasteners in Automotive Exhaust Systems
- Trends in High Temperature Alloys

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